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SCIENCE BULLETIN

VOL. XXXV, PT. 1] JULY 1, 1952 [NO. 1

A Reclassification of Western Hemisphere Typhlocybinae (Homoptera, Cicadellidae)[1]

BY

DAVID A. YOUNG, JR.[2,3]

ABSTRACT: The subfamily is treated for the New World. Keys to tribes, genera, and subgenera are included with illustrations of structures useful in classification. Describes four tribes, one of which is new; 58 genera and subgenera, 32 of which are new (including two old and two new genera under joint authorship with Mr. Paul J. Christian). New tribe: *Erythroneurini;* new genera: *Hadralebra* (for *Dikraneura* (*Hyloidea*) *laticeps* Osborn), *Rabela* (for *Protalebra tabebuiae* Dozier), *Orsalebra* (for *Orsalebra robusta,* n. sp.), *Balera* (for *Dikraneura pellucida* Osborn), *Diceratalebra* (for *Alebra sanguinolinea* Baker), *Trypanalebra* (for *Protalebra maculata* Baker), *Brunerella* (for *Brunerella magnifica,* n. sp.), *Habralebra* (for *Protalebra nicaraguensis* Baker), *Elabra* (for *Protalebra eburneola* Osborn), *Rhabdotalebra* (for *Protalebra octolineata* Baker), *Protalebrella* (for *Protalebra brasiliensis* Baker), *Endoxoneura* (for *Dikraneura* (*Hyloidea*) *splendidula* Osborn), *Kidrella* (for *Dikraneura santana* Beamer), *Donidea* (for *Typhlocyba verticis* Baker), *Dikrellidia* (for *Dikraneura bilineata* Osborn), *Kunzella* (for *Dikraneura marginella* Baker), *Neodikrella* (for *Dikraneura* (*Hyloidea*) *disconotata* Osborn), *Sarascarta* (for *Dikraneura* (*Hyloidea*) *fulva* Osborn), *Buritia* (for *Dikraneura lepida* McAtee), *Saranella* (for *Dikraneura* (*Hyloidea*) *micronotata* Osborn), *Eupteroidea* (for *Typhlocyba stellulata* Burmeister) *Henribautia* Young and Christian (for *Typhlocyba nigricephala* Beamer), *Ossiannilssonia* Young and Christian (for *Typhlocyba berenice* McAtee), *Neojoruma* (for *Joruma adusta* McAtee), *Paulomanus* (for *Paulomanus cecropiae,* n. sp.), *Beamerella* (for *Erythroneura tropicalis* Osborn); new subgenera: *Delongia* (for *Dikraneura luna* DeLong and Caldwell) in genus *Dikraneura, Readionia* (for *Dikraneura readionis* Lawson) in genus *Dikrella, Jorumidia* (for *Joruma curvata* Osborn) in genus *Joruma,* and *Erasmoneura* (for *Erythroneura vulnerata* Fitch), *Erythridula* (for *Tettigonia obliqua* Say), and *Eratoneura* (for *Erythroneura dira* Beamer) in genus *Erythroneura;* new synonymy: *Paralebra* McAtee (= *Plagalebra* McAtee), *Dicranoneura* Douglas (= *Forcipata* DeLong and Caldwell),

1. Contribution number 763 from the Department of Entomology of the University of Kansas, Lawrence.
2. In joint authorship with Mr. Paul J. Christian for genera *Henribautia, Ossiannilssonia, Ribautiana,* and *Typhlocyba.*
3. Present address: Division of Insect Identification, U. S. Department of Agriculture, Washington, D. C.

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Parallaxis McAtee (= *Erythria* Fieber of Baker, in part), *Alconeura* (*Hyloidea*) McAtee (= *Dikraneuroidea* Lawson), *Joruma* McAtee (= *Jorumella* McAtee), *Rabela tabebuiae* (Dozier) (= *Protalebra bicincta* Osborn), *Elabra attenuata* (Osborn) (= *Dikraneura albidula* Osborn), *Parallaxis donaldsoni* (Baker) (= *Parallaxis vacillans* McAtee), *Parallaxis guzmani* (Baker) (= *Parallaxis clathrata* McAtee), *Donidea verticis* (Baker) (= *Dikraneura* (*Hyloidea*) *eburnea* Osborn), *Dikrella californica* var. *imbellis* (Lawson) (= *Dikraneura nevadensis* Lawson), *Idona beameri,* n. n. (= *Idona hyalina* (Beamer *nec* Osborn)), *Hymetta balteata* McAtee (= *Hymetta distincta* Fairbairn), Typhlocyba *querci* var. *querci* (Fitch) (= *Typhlocyba gillettei* var. *fitchii* McAtee) [Young and Christian], *Beamerella tropicalis* (Osborn) (= *Erythroneura similis* Osborn), *Empoasca breviceps* (Osborn) (= *Dikraneura alebroidea* Osborn), *Alconeura santaritana,* n. n. (= *Alconeura beameri* Griffith *nec* Lawson), *Empoasca ornatella,* n. n. (= *Empoasca ornata* Oman *nec* Osborn); new status: *Aphanalebra* McAtee, *Kallebra* McAtee, and *Paralebra* McAtee elevated to genus, *Hyloidea* McAtee reduced to subgenus of *Alconeura* Ball and DeLong, *Rhabdotalebra similis* (McAtee) elevated to species; *Alebra dorsalis* Gillette moved to Deltocephalini.

The subgenus *Scinda* DeLong and Ruppel is elevated to generic rank.

INTRODUCTION

The present problem was undertaken at the joint suggestion of Dr. R. H. Beamer of the University of Kansas, and Dr. P. W. Oman of the Division of Insect Identification of the United States Department of Agriculture.

The last treatment of the genera of the subfamily was that of McAtee (1934a). That classification was based primarily on the venation of the apical portions of the fore and hind wings, and aside from those characters mentioned in the key, the genera were not characterized. The venation of the base of the hind wings was not taken into account in the key, nor were the characters of the male genitalia, although genital characters already had come to be of recognized value in establishing the identity of species.

The emphasis which the venation of the wing apex received as a result of the McAtee classification led generally to the oversight of many other useful characters, and indeed to the neglect of the most significant characters of the wings themselves, the venation of the vannal region of the hind wings. Following the McAtee classification, workers describing new species placed these in already existing genera, frequently without pausing to analyze their relationships to the genotypes involved. There resulted many hetergeneous genera, which could be recognized almost solely on the basis of the venation of the wing apices, and occasionally not even on that character.

Since 1934, Ribaut (1936b), in a study of the French Typhlocybinae, recognized interspecific relationships and placed the French species in groups, which in some cases constitute genera, and in others constitute species groups within genera. Oman (1949a) described two new genera in the subfamily, and pointed out the need for a critical study of the group. DeLong and co-workers have also described several genera and subgenera.

The aim of the present paper has been to restudy the Western Hemisphere typhlocybine genera with a view to a fuller characterization of genera and the development of a more natural system of classification. It has been necessary, in so doing, to describe a number of new genera. Moreover, in several instances, it has been found necessary to base a new genus on a single species, most often in cases involving Neotropical species. The tropics of the New World, however, have been so poorly covered by collectors that the writer subscribes to the opinion that many of the Neotropical genera, which are monobasic in the present treatment are not likely to remain so when more collecting has been done.

In other cases, the same paucity of material has led to the retention of some genera which are admittedly heterogeneous, for example in the Alebrini, where forms which were fairly closely related morphologically were retained in the same genus for want of sufficient material to establish where discontinuity in variation might occur.

THE SUBFAMILY TYPHLOCYBINAE

Definition. Relatively few constant characters have been found in this group of diversified insects. Most of the characters formerly cited as diagnostic for the subfamily have failed to survive the collection and study of additional materials.

The comparatively small size of the leafhoppers of the subfamily is useful, to some extent, in identifying it, but the smallest members of some other subfamilies are exceeded in size by the largest Typhlocybinae. There has been a reduction in area and venation in the apical portion of the costal area of the hind wing, but such a reduction is present in some non-typhlocybine leafhoppers, and its degree is variable within the Typhlocybinae.

From a practical standpoint, all leafhoppers which lack *discal* branching of the longitudinal veins of the fore wings, basad of the bases of the apical cells, may be placed in this subfamily. And even this character is not infallible, for in certain Alebrini, the occurrence of adventitious cross veins may present the appearance of branched

longitudinal veins, an appearance certain to be confusing to one not familiar with the group. Coincident with this lack of discal branching of the longitudinal veins, is the occurrence of only two anteapical cells, a character which does, however, occur in another subfamily.

Nomenclature. This work has employed the name *Typhlocybinae* in its title, because that name conforms to the practice of retaining suprageneric names with priority. Apparently the first use of the group name was that of Kirschbaum (1868b:16) who used "Typhlocybidae" as a subfamily name.

If one did subscribe to using the oldest generic name as a basis for a subfamily name, then because of a nomenclatorial problem concerning the true identity of the genus *Cicadella* Duméril, the correct name of the subfamily would be presently in question. Duméril (1806a), in a publication which listed a synoptic table of some families of Homoptera, divided the leafhoppers into two groups: those with ocelli, and those without ocelli. He mentioned the name *Cicadella* in his discussion of the group in which ocelli were present.

In the same year, Froriep (1806a), in a German translation of the Duméril work, listed *Cicadella vittata* (L.) as an example of the group in which ocelli were present, and this was the first (and at that time the only) included species. On the basis of this, *Cicada vittata* Linnaeus can be considered the type of the genus *Cicadella* Duméril, and if this course is followed, then *Cicadella* Duméril is a genus in the subfamily under treatment, and incidentally the oldest genus, and the subfamily could be appropriately designated "Cicadellinae."

But, on the other hand, as Wagner (1950a) has pointed out, *Cicada vittata* L. is a species which does not have ocelli, and its selection by Froriep as an example of *Cicadella* Duméril can be considered to have violated the intent of Duméril. Wagner therefore designated *Cicada viridis* L. as type of the genus *Cicadella* Duméril, pointing out that this species *does* have ocelli, and does not, therefore, violate the intent of Duméril. Moreover, he suggested that this selection of type of the genus had the added advantage of making *Cicadella* Duméril and *Cicadella* Latreille isogenotypic, thereby relegating the latter to synonymy under the former.

The writer subscribes to the opinion that the solution is not as simple as Wagner suggests. In the first place, it seems that Froriep's designation of *Cicada vittata* L. as an example of *Cicadella* Duméril may be construed as a type fixation, in spite of the fact that

it does not conform to the original characterization of Duméril, unless a ruling to the contrary is forthcoming from the International Commission on Zoological Nomenclature. Certainly the arbitrary selection of a type which violates, in one character or more, the original description of a genus is no novel occurrence. Moreover, as Oman (*in litt.*) has pointed out, Duméril himself, in a subsequent paper (1816a) listed *vittata* as an included species in his own genus *Cicadella*.

Doctor Wagner's action was probably motivated partly by the desire to restore the name *Cicadella* to the group recently designated Tettigellinae, which group was called Cicadellinae based on *Cicadella* Latreille (type, *Cicada viridis* L., by subsequent designation of Van Duzee, 1917) until 1946 (China and Fennah 1946a). The writer agrees that such a course would minimize the confusion in the literature, and Doctor Wagner's action is followed herein. It is hoped, however, that the status of *Cicadella* Duméril will be stabilized by a ruling of the Commission.

The removal of the name *Cicadella* from this subfamily restores the name *Eupteryx* as the oldest genus, and the subfamily could be appropriately designated Eupteryginae.

Phylogeny. The relationship of the Typhlocybinae to other subfamilies has long been obscure. The present work has done little to clarify this question, and the writer is unable to state which of the various subfamilies of Cicadellidae are probably closely related to the Typhlocybinae, or indeed whether only a single subfamily is to be sought in this connection.

It would be impractical to hope for any solution of the problem of phylogeny within the subfamily from a study of the Western Hemisphere forms alone, or even with a consideration of Palaearctic forms as well. It has been found convenient, however, in the present treatment, to represent *relationships suggested by morphological considerations* in a conventional "tree" form in two instances. It is hoped that other students of the group will look upon these as they have been considered by the writer—as tentative, and as a basis for further investigation in the light of studies of species from other faunal regions. Further remarks on phylogeny are included in the sections below, which deal with tribal characteristics.

ACKNOWLEDGMENTS

The writer is greatly indebted to Professor R. H. Beamer of the University of Kansas under whose direction this work was performed, and to Dr. P. W. Oman of the Division of Insect Identification of the United States Department of Agriculture who was constantly in touch with the progress of the work, who made numerous helpful suggestions, who was most hospitable to the writer during a visit to Washington, D. C., and who loaned Plate 1 for use in this work.

The entire staff of the Department of Entomology of the University of Kansas have taken a keen interest in the development of the work, and have discussed several phases of the problem with the writer, often making useful suggestions.

The following loaned specimens from the collections listed: Dr. P. W. Oman, specimens from the U. S. National Museum; Dr. Walter R. Sweadner, specimens from the Carnegie Museum at Pittsburgh, Pennsylvania; Dr. Dwight M. DeLong, specimens from his own collection; Dr. A. Willink. specimens from the Miguel Lillo Foundation collection at Tucuman, Argentina; Dr. José A. DeCarlo, specimens from the Museum of Natural Science at Buenos Aire, Argentina; Dr. S. C. Bruner, specimens from the Department of Phytopathology and Entomology of the Cuban Ministry of Agriculture; Dr. Joseph C. Bequaert, specimens from the Museum of Comparative Zoology; Dr. Henry Dietrich, specimens from the Cornell University Collection; Dr. Miles D. McCarthy, specimens from the Pomona College collection; Dr. H. H. Ross, specimens from the Illinois Natural History Survey Collection; Dr. E. S. Ross, specimens from the California Academy of Science collection; Dr. C. E. Pemberton, specimens from the collection of the Hawaiian Sugar Planters Association; Dr. R. Malaise, a specimen from the Riksmuseum of Natural History in Stockholm.

To Dr. Walter R. Sweadner and to Dr. Dwight M. DeLong, the writer is grateful for making study facilities available at Carnegie Museum and at Ohio State University, during visits to these institutions.

Dr. Frej Ossiannilsson of Uppsala, Sweden, has been most cooperative in determining and loaning specimens of several species.

Mr. Paul J. Christian, of the University of Kansas, has been of great assistance in the present treatment of *Typhlocyba,* and has collaborated in the description of several segregates from this complex.

The University of Louisville has helped greatly through a grant-in-aid, in facilitating the work.

Plate 1 was made by Mr. Arthur D. Cushman of the Division of Insect Identification, U. S. Department of Agriculture. Mrs. Barbara Rozen, of the University of Kansas, has inked most of the remainder of the illustrations used herein.

To the above persons and institutions the writer is obliged, and to them rightly belongs much of the credit for whatever herein may be found to be creditable.

TECHNIQUE

Techniques are, in the final analysis, individual matters, and there are probably as many techniques and modifications of techniques as there are experts. Any technique which will make the internal male genitalia available for study under very high magnification is a suitable one for this group of insects, provided the structures are not damaged in the process. The following method is that preferred by the writer, for the study of the genital capsule and its contents. Little of it is original.

The entire abdomen is removed from the specimen and placed in ten percent caustic potash which is then heated to the boiling point. The abdomen is allowed to remain in the hot caustic for a period which varies with the degree of sclerotization of the specimen. In heavily sclerotized specimens, the abdomen is removed from the solution when the conjunctivae become conspicuously pale. In less heavily sclerotized specimens, the abdomen is removed from the solution when it becomes hyaline. The abdomen is placed in distilled water for about ten minutes, then transferred to acid fuchsin (0.5%). After a few minutes, the abdomen is placed in acidulated distilled water for a few minutes to remove the excess stain. It is then placed in a hollow-ground slide in a drop of acidulated glycerine (made by adding two drops of glacial acetic acid to a dropper bottle of glycerine). The genital capsule is then removed from the abdomen and studied *in toto*.

The straining procedure outlined above permits minute examination of the capsule with "high dry" of the compound microscope, and the resolution of even minute microsetae.

After the *in toto* examination, using very small needles (*minuten nadeln*), the conjunctiva at the base of the anal tube is cut through, throughout its circumference, the anal hooks, if present, are loosened with gentle pressure, and the needles are passed between the

aedeagus and the anal tube to sever the minute connections which remain after the maceration process. The anal tube, with its hooks, is thus removed in one piece.

One of the needles is next inserted through the anterior opening of the capsule (left by removal of the abdomen) and placed laterad of and in contact with, but not pressing upon, one of the styles at its base. The other needle is inserted through the opening left by removal of the anal tube and its point placed slightly caudad of the point of the first needle. A gentle mesad nudge of the second needle separates the style from the plate to which it is articulated. The procedure is then repeated for the opposite style. The needles are then moved in an arc around the dorsal apodeme as a center, to sever any remaining connections between the aedeagus and the capsule wall, and the internal genitalia are then removed from the capsule which is left intact. Difficulties occur in the Alebrini, where the articulating surface between the style and the male plate is quite long. Difficulty is also experienced in some Alebrini and in *Dicranoneura* where the connective is membranous and hence not of aid in sustaining the relative positions of the internal structures. In such cases, the writer prefers to leave the internal genitalia attached to the male plates (which thus serve to support them) and to remove the pleural and dorsal walls of the ninth segment in one piece so that the internal structures can be seen without any intervening integument to diminish the resolution.

When drawings are to be made, the author uses a very small amount of Boric Acid Ointment, as an adhesive, smeared in the concavity of the slide before the glycerine is added. The specimen may be studied under the binocular dissecting microscope, from several different aspects, without any contact with the adhesive. After study *in situ*, the capsule is oriented for drawing and moved to the edge of the adhesive, and its anterior rim pressed lightly into the adhesive. The slide is now moved to the monocular microscope for drawing. The Abbé condenser of the compound microscope will compensate for a great degree of difference in intensity of stain. Destaining is seldom necessary, but may be accomplished quickly by washing in water briefly, or more slowly by allowing the structures to remain in glycerine. In orienting the structures with the dissecting microscope, good results are achieved using a dark background behind the translucent adhesive and a light background (a piece of white paper) beneath the structures being oriented.

In making drawings of the genitalia, a ruled ocular and co-ordinate paper were employed. Because of the great variation in size

of structures in different species, the drawings were made at several different magnifications, as indicated opposite the plates. In all of the drawings of the genital capsule, the anal tube is diagrammatic.

There has been some difference of opinion among workers as to the advisability of removing the internal male genitalia, or leaving them in the capsule. Advocates of the latter method are probably motivated by a desire not to distort the styles, which may rotate somewhat at their articulation with the connective, during or after dissection. If the styles are drawn in detail, however, another worker will have a sufficient number of reference points to orient the structures properly for comparison. If drawings are made with the styles oriented in such a way that their broadest portion is uppermost, the orientation is easily duplicated for comparison. This has been done in a number of instances in the present paper, and the view has been designated "broad aspect." Actually, it may be lateral or ventrolateral. Its use enables permanent slide mounts to be used to advantage where a worker desires to employ such a technique.

After study, the internal structures and the anal tube are placed within the genital capsule, and the latter placed within the empty abdominal wall which thus serves as a container for the smaller structures. The abdomen is next placed in a drop or two of glycerine in the bottom of a small vial through the cork of which the pin bearing the specimen is thrust diagonally, so that the glycerine tends to remain at the bottom of the vial out of contact with the cork.

For taxonomic purposes the wings may be exposed for observation by inserting a dull-pointed needle, from the rear, beneath the combined wings, between the wings and the dorsum of the abdomen, keeping the long axis of the needle parallel to the midline of the dorsum. The needle is then lifted vertically, so that it pulls out, as an overlying flap, the mesal margin of whichever hind wing lies uppermost. If care is employed, no damage to the specimen results, and the venation at the base of the hind wing can be seen in the flap thus exposed. The venation at the apex of the hind wing can be seen by gently lifting the fore wing and pulling it slightly laterad.

If wing slides are to be made, the dry wings are removed from one side of the specimen and placed on a clean dry slide. The jugal lobe is unfolded and pressure applied to one point along the jugal fold to keep the lobe from springing back to its

original position. Four small drops of plastic adhesive are placed on the slide to hold the corners of a square cover glass, which is next applied and pressed slightly to flatten the wings. An air mount is thus obtained. For drawing these, the writer employs a projection apparatus. The width of the wing veins was not indicated in any of the drawings included here.

In the case of most of the Carnegie Museum specimens, the wings were torn badly in many instances, and greatly folded and stuck together in other instances. It was possible, by immersing the specimens in water, to remove the wings without further damage to them. The wings were then flattened and unfolded or uncoiled against the surface film of a drop of water, which was allowed to dry. The cover glass was applied as described above to form an air mount.

MORPHOLOGY

It is not within the scope of the present undertaking to give a detailed account of the morphology of the typhlocybine leafhoppers. For a more detailed account than that which follows, the reader is referred to recent works of Oman (1949a), Ribaut (1936b), Kramer (1950a) and Evans (1946a). In general, the terms used are those which have been used over a long period of time by taxonomists in the group.

The wings. The homologies of the wing veins have not yet been settled to the satisfaction of workers in the group, with the result that some of the veins still bear names of convenience, rather than names which express their relationship to a typical venation pattern. It seems fairly generally agreed that the three principal longitudinal veins are R, M, and Cu in both wings. The system used by Beamer (1938a) is used for the fore wing in this treatment. The apical cells, for convenience, have been numbered from inner to radial margin. Oman (1949a) employed this unusual method of numbering the apical cells because supernumerary cross veins to the costa occur in the preapical region of the fore wing fairly commonly in some groups of leafhoppers (occasionally in the subfamily under discussion). Such veinlets rarely occur in the commissural preapical region. Thus, starting from the commissural margin of the fore wing, less confusion results than would occur if the numbers started from the costal margin.

In the hind wing, the posterior branch of vein R may retain its separate identity to its apex, or it may undergo a preapical fusion with the apical portion of the anterior branch of vein M (Plate 2,

fig. 5, "R + M"). The m-cu cross vein is usually diagonal, so that Cu_1 appears to be forked apically, but what appears to be the anterior branch is actually m-cu continued as M_{3+4} (fig. 5) according to recent studies, and Cu_1 is actually unbranched. Vein Cu_2 is always unbranched in this subfamily. The hind wing possesses two folds, one functional fold, the jugal fold, which delimits the jugal lobe, and a second more anterior non-functional vannal fold. Between these folds is the vannal area of the wing. It exhibits a maximum of two veins, here designated 1V and 2V which are always at least partially fused. The apices of at least some of the longitudinal veins are prolonged in a common submarginal vein, of variable extent between species groups.

The longitudinal veins of the hind wings present many good generic characters, and some characters of suprageneric value. The vannal veins appear to be very conservative, as does the course of vein Cu_2. The apex of Cu_1, in some groups, has undergone coalescence with M_{3+4}, a development which appears to have occurred polyphyletically. In the Alebrini, the degree of fusion of R and M is a somewhat variable character between species of a genus, and even between wings of a single specimen.

As in the case of the fore wings, supernumerary cross veins frequently occur also in the hind wings, but are easily recognized as such from their position. A cross vein is typically present between R and M when these are not fused apically. This cross vein and the base of vein M_{3+4} (which has the appearance of a cross vein) have been found to be quite inconstant in position.

In the descriptions which follow, in discussing comparative lengths and widths of cells, unless otherwise designated, the greatest length or width is meant. In the case of the apical cells of the fore wing, the width is measured at right angles to the long axis of the wing even though this may be the greatest dimension of the cell.

The male genital capsule. The tergum and pleura of the ninth segment are collectively designated the *pygofer.* From the very narrow sclerotized ventral portion of the ninth segment there arise a pair of lobose appendages which extend caudad beneath the pygofer. The homology of these *male plates* is not known, but it is generally held that they are not true segmental appendages. In most genera, the male plates are flat pouchlike structures, but in the Alebrini, they appear to be cylindrical apically, perhaps as a result of a rolling and fusing process. Both the pygofer and the male plates usually bear setae, the general arrangement of which is frequently constant for a given genus. The pygofer often bears

a pair or pairs of *pygofer processes* (or *pygofer hooks*) which arise as projections from the pygofer wall. They may arise as thickenings of the dorsal or ventral portion of the wall, or from the posterior pygofer margin. They are constant in manner of origin in some genera, variable in one or both of these features in others. In illustrating the capsule, the pygofer hooks have been drawn *in situ* unless this complicates the illustration too much or tends to obscure other features. Occasionally, the anal tube gives rise to sclerotized processes, the *anal hooks*.

The internal male genitalia. The aedeagus (Plate 2, fig. 7) is essentially a campanulate structure, with the terminal opening at the narrow end. The broader basal opening is here designated the *genital atrium,* and its border the *atrial rim.* The term *shaft* is restricted to that portion of the aedeagus traversed by the completely enclosed gonoduct. The shaft is usually directed dorsocaudad. At the periphery of the genital atrium, usually as a modification of the atrial rim, an apodeme occurs. Usually it is dorsal, but it may be paired, arising bilaterally from the atrial rim. Frequently, it is of similar form in closely related species (e. g. *Kunzeana* spp.). Occasionally, the atrium is preceded by a conspicuous preatrial portion, here designated the *preatrium.* When a preatrium is present, it articulates with the connective, and when it is absent, the articulation with rare exceptions is with the ventral portion of the atrial rim. Aedeagal processes occur in great variety. They may be preatrial or atrial in origin, or they may arise on the shaft or on the apodeme. In the descriptions which follow, the processes are designated as to their origin wherever possible. Occasionally they occur in such a manner as to be difficult of definition, for example in the region of the ventral limit of the preatrium and the beginning of the shaft. In such cases, they are referred to simply as "aedeagal processes" with further description of their point of origin.

The connective articulates with the styles laterally (Plate 2, fig. 8), and with the base of the aedeagus apically. It occurs as a linear cross-bar, a triangle, in the form of the letters "U" or "V" or "Y" or in the form of a trapezoid. It may possess various thickenings. In most cases the apex is curved dorsad and the aedeagus articulates with the subterminal portion, but the articulation may be terminal, dorsal, or much more basad. Occasionally the connective is thin and membranous and observed only with difficulty, even with good staining. Frequently, the form of the connective is constant within a genus.

The *styles* (Plate 2, fig. 8) occur one on each side of the connective. They consist each of a short cephalad-produced portion and a longer caudad-produced portion. The anterior portion is quite variable in form and appears to have little taxonomic value. The posterior portion is quite conservative in form and frequently exhibits characters diagnostic for genera. In the remainder of this treatment, in referring to the length of the style, unless otherwise designated, only the posterior portion (connective to posterior apex) is under consideration.

In form, the style may be slender and tubular, or it may exhibit expansions in one or more planes, forming a lobe or lobes. It may bear setae which are quite constant in arrangement. Apparently in the higher genera of Erythroneurini, it has undergone a first, then a second apical extension from a simple form with an expanded apex. The accuracy of this idea, based purely on the morphology of the style apices cannot be established here. It might be strengthened or weakened by careful ontogenetic studies of the development of the apex of the style in species of *Erythroneura*. In figures 8 to 15, a series of style apices have been illustrated to show what appears to be first, an apical extension from a style with a flattened apex, such as occurs in *Dikrellidia* (fig. 8), for example; second, a flattening of this first extension from the apex of the style to form a broad, flat extension, as in *Zygina* (fig. 9), and third, a second extension from the apex of the first to form the posterior point (and the anterior point, when present) of the style, as in many *Erythroneura* species.

Following the above hypothesis, the parts of the style have been labeled accordingly, in order to make possible more precise descriptions. The lobe of the basic style pattern is designated the *preapical lobe,* and the *first* and *second extensions* have been designated as such. The mesal extremity of the first extension, in keeping with the terminology established in the literature, is designated the *heel,* and the posterior extremity of the second extension, the *posterior point.*

In some members of the Alebrini, a preapical expansion of the style occurs which apparently is not homologous with the preapical lobe mentioned above, for there is no indication that the narrower apical portion is of the nature of an extension, for no line of demarcation can be seen between the basal portion and the "extension."

Genitalia preparations of the Alebrini, usually have preserved the

bulbus ejaculatorius and the duct leading from it to the genital atrium. The same structure is seldom preserved in macerated specimens in other groups.

The head. The form of the head has been little used in the present system of classification, in spite of the fact that its form is quite characteristic, so much so that experienced taxonomists in Cicadellidae may frequently make an accurate determination of a genus from the head alone. Reducing the general appearance of the head to tangible characters represents a problem not solved in the course of this work. It is a problem rendered more difficult by the difference in head shape between male and female. The writer has found the width of the ocellocular area (Plate 1, fig. 2) to be useful in certain descriptions. This distance is measured along a line across the top of and tangential to the first antennal segment, from inner margin of eye to the inner margin of the antennal base.

LITERATURE

Full bibliographic references are not given in the text or in the species lists. Instead, references are made to the appropriate citation in "Bibliography of the Homoptera," by Z. P. Metcalf (1942a), which may be consulted for the full reference. In the species lists, the reference to the bibliography is followed by a colon, followed in turn by the page number on which the original description of the species occurs. In the case of references not included in the Metcalf bibliography, the bibliography at the end of the present paper should be consulted.

In those instances where the original description was not verified by the writer, Oman's (1949a) work has been followed, usually, and these references have been indicated ("*fide* Oman") in the species lists.

PROCEDURE

An attempt has been made to study as many species as possible, comparing them with the types of the genera, and placing them accordingly, describing new genera where such a course was indicated. The genera have been as completely characterized as possible. Where some characters have appeared of unusual value in diagnosis, they have been italicized in the descriptions.

Except in the case of the types of genera, no particular effort has been made to discover synonyms, and doubtless several of these occur in the lists of species which accompany the genera. Except in a few cases, varieties have not been listed.

CLASSIFICATION

KEY TO TRIBES OF TYPHLOCYBINAE

1. Fore wing with an appendix ..... Alebrini
   Fore wing without an appendix 2
2. Hind wing with submarginal vein present (except in *Typhlocybella*) *and* extending laterad then basad along costa beyond apex of vein "R + M" ..... Dikraneurini
   Hind wing with submarginal vein present or absent at wing apex, when present not extending beyond apex of posterior branch of R (or "R + M" where fusion occurs) 3
3. Vein 1V absent; style with distinct preapical lobe and apical extension ..... Erythroneurini
   Vein 1V present; style without distinct preapical lobe and apical extension ..... Typhlocybini

TRIBE ALEBRINI

The species in this tribe all possess both vannal veins in the hind wing. In the fore wing, the fourth apical cell does not attain the wing apex, and an appendix is present, extending to or around the wing apex. Discal macrosetae are nearly always present on the pygofer, and usually a small group of microsetae occurs on the disc near the outer basal angle of the male plate. The styles usually lack a preapical lobe, and in those species in which the lobe is present, the narrower more caudad remainder of the style is seldom clearly of the nature of an extension as it usually is in other tribes where this feature is present. The style is more intimately fused with the male plate than in other tribes, rendering dissection more difficult. The male plates are usually rolled apically, presenting a tubular appearance in cleared specimens. In macerated specimens, the *bulbus ejaculatorius* and the duct leading from it to the genital atrium are nearly always preserved.

The submarginal vein of the hind wing is usually close to, and often confluent with the apical wing margin, and it is wanting occasionally.

In all species of this tribe, in cleared specimens, the mid-dorsal line of the genital capsule appears membranous to the apex of the preceding segment, or if sclerotized medially near the base of the ninth segment, then the sclerotization appears to be secondary, arising in the membranous portion, which is visible laterally. In all other tribes, the sclerotization is continuous from pleural region to pleural region of the ninth segment, over the dorsum, although the dorsal arch of sclerotized integument may be only a narrow basal band.

KEY TO GENERA OF THE TRIBE ALEBRINI

1. Head short, broad, enclosing pronotum nearly to its hind margin; male plates very long, greatly exceeding tip of pygofer; pygofer lacking setae over disc ..... *Hadralebra*
   Head not unusually broad; male plates not greatly exceeding tip of pygofer; pygofer with setae usually present on disc (exception: *Balera, Rhabdotalebra*) 2
2. Fore wing with two longitudinal veins confluent proximad of bases of apical cells 3
   Fore wing without confluent longitudinal veins proximad of apical cells (longitudinal veins occasionally connected by a cross vein) 4
3. Fore wing with veins M and Cu confluent proximad of apical cells ..... *Aphanalebra*
   Fore wing with veins R and M confluent proximad of bases of apical cells ..... *Rabela*
4. Fore wing with only three apical cells as result of fusion of second and third apical veins ..... *Kallebra*
   Fore wing with four apical cells; second and third apical veins never completely fused 5
5. Hind wing with Cu_2 confluent with submarginal vein at point distad of apparent forking of Cu_1 ..... *Orsalebra*
   Hind wing with Cu_2 confluent with submarginal vein at point opposite to or proximad of apparent forking of Cu_1 6
6. Aedeagal shaft, in dorsal aspect, broadly inflated throughout its length; style apex strongly sigmoid ..... *Balera*
   Aedeagal shaft, in dorsal aspect, not strongly inflated throughout its length; style apex straight or occasionally sinuate, not strongly sigmoid 7
7. Aedeagus, in lateral view, appearing bifurcate at apex, *Diceratalebra*
   Aedeagus, in lateral view, not appearing bifurcate at apex 8
8. Connective membranous 9
   Connective, at least partially, heavily sclerotized 10
9. Fore wing with apex of cell R broadly expanded, much broader than cell M; aedeagus with single median ventral atrial process ..... *Trypanalebra*
   Fore wing with apex of cell R not broadly expanded, not or slightly broader than cell M; aedeagus without ventral atrial process ..... *Paralebra*
10. Head not distinctly produced medially, in dorsal aspect, its anterior and posterior margins subparallel; eyes massive, the median length of crown exceeding distance between eyes 11
    Head distinctly produced medially, the margins not subparallel, or if so, then eyes small and the median length of crown much less than distance between eyes 12
11. Fore wing with appendix extending completely around apex ..... *Alebra*
    Fore wing with appendix not extending around apex ..... *Brunerella*
12. Fore wing with apex of cell M transverse, occurring distad of basal third of inner apical cell 13
    Fore wing with apex of cell M oblique or angular, or if transverse, then occurring opposite basal third of inner apical cell 14

13. Base of outer apical cell nearly opposite apex of cell R; aedeagus in lateral aspect, with width of unpaired ventral process (rarely absent) greatly exceeding width of midpoint of shaft ..... *Habralebra*
    Base of outer apical cell much proximad of apex of cell R; unpaired ventral aedeagal process, when present, narrower than shaft ..... *Elabra*
14. Pygofer with submarginal macrosetae grouped very near posterodorsal margin; aedeagus in lateral aspect with apodeme saddle-shaped ..... *Rhabdotalebra*
    Pygofer with discal macrosetae; aedeagal apodeme not saddle-shaped in lateral aspect 15
15. Pygofer hooks various in origin, but not dorsal ..... *Protalebra*
    Pygofer hooks dorsal in origin ..... *Protalebrella*

Genus *Hadralebra*, nov.

(Pl. 4, fig. 16)

Type of the genus, *Dikraneura* (*Hyloidea*) *laticeps* Osborn.

Hind wings: submarginal vein present, extending at least to apex of wing; vein Cu_1 apparently branched apically (*i. e.* its apical portion not fused with M_{3+4}); vein Cu_2 confluent with submarginal vein at point proximad of vein m-cu.

Fore wings: fourth apical cell short, subtrapezoidal; other apical cells successively shorter towards commissural margin.

Genital capsule: male plates greatly elongate, *greatly exceeding tip of pygofer, without macrosetae; pygofer lacking setae over disc;* pygofer hooks ventral in origin.

Internal male genitalia: style short, broad, flattened dorsoventrally, without preapical lobe or apical extension; connective massive, plate-like, its anterior margin broadly convex, its apex extending nearly as far caudad as style apices, the aedeagal articulation terminal in a socket; aedeagus with preatrium very long, shaft very short.

The head is conspicuously broader, in dorsal aspect, than the rest of the body, and surrounds the pronotum laterally except for the apical portions of the lateral margins.

This genus is unique, among those studied, in genital structure, and has several features which may be considered primitive, especially the form of the tips of the styles. Unfortunately the wing venation cannot be completely described, because the single specimen of the type species possessed only wing fragments.

The genus is known only from the type species, from Bolivia.

Hadralebra laticeps (Osborn), 1928a: 277 (*Dikraneura* [*Hyloidea*]), new combination

Genus *Aphanalebra* McAtee

(Pl. 4, fig. 17)

Protalebra (*Aphanalebra*) McAtee. Journ. New York Ent. Soc., vol. 34, p. 152. 1926, new status.

Type of the genus, *Protalebra unipuncta* Baker, by original designation.

Hind wings: vein 1V branching from vein 2V near its base; submarginal vein confluent with apical wing margin; posterior branch of R and M_{1+2} not confluent, separate throughout their length, connected by a preapical cross vein; vein Cu_1 appearing branched apically; vein Cu_2 attaining submarginal vein near middle of wing, much basad of vein m-cu.

Fore wings: appendix not extending around wing apex; first apical cell longer than other apical cells, slender, much broader at base than at apex; second apical cell angular basally, petiolate, with sides subparallel; third apical cell very small, triangular, long-petiolate; fourth apical cell open basally, extending apicad nearly to wing apex; *veins M and Cu fused basad of base of first apical cell;* wing apex smoothly rounded.

Genital capsule: male plate elongate, slender, in ventral aspect with lateral margin gradually tapered on apical half to rounded apex; in lateral aspect plate exceeding pygofer and with oblique row of macrosetae over apical half, with group of close-set microsetae below lateral margin near middle its length, and several irregularly arranged microsetae more distad; pygofer, in lateral aspect, with oblique row of macrosetae over disc and cluster of similar setae above posteroventral margin, a small group of ventral microsetae above basal third of male plate; posteroventral pygofer margin extending mesad as thick process bifid at extremity.

Internal male genitalia: style without preapical lobe or apical extension, in dorsal aspect gradually narrowed posteriorly to convexly truncate apex, apical fifth slightly curved laterad; connective membranous; aedeagus with unilateral apodemal process on left side, nearly as long as shaft, the process extending directly ventrad, then curved and directed posterodorsad, shaft in lateral aspect sharply decurved at extreme apex, bisinuate basad of recurved portion, apodeme Y-shaped, dorsal portion of atrium attached ventrally near origin of stem of "Y"; gonoduct with curious tightly-coiled appearance in apical two-thirds, preatrium wanting.

The head, in dorsal aspect, is much narrower than the pronotum, and well produced medially, longer medially than next the eye. The anterior margin is broadly rounded. The median length of the

pronotum is at least twice the median length of the crown, with lateral margins greatly divergent posteriorly and posterior margin shallowly emarginate. In lateral aspect, the face is flat, its contour strongly divergent from the line of the dorsum. The pleural portion of the pronotum is much broader than the ocellocular area.

The type species is from Brazil.

Aphanalebra unipuncta (Baker), 1899b: 404 (*Protalebra*)

Genus *Rabela*, nov.

(Pl. 5, fig. 18)

Type of the genus, *Protalebra tabebuiae* Dozier.

Hind wings: vein 1V branching from vein 2V near its mid-point; submarginal vein wanting apically; longitudinal veins not attaining wing apex; posterior branch of R and M_{1+2} concurrent for a short distance preapically, separate apically, the free part of the posterior branch of R only a short spur; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein near middle of wing, much basad of vein m-cu.

Fore wings: appendix not extending around wing apex; *veins R and M concurrent before inner basal angle of outer apical cell*, all apical veins thus arising from cell M; first and second apical cells long, slender, the first much broader than second; third apical cell long-stalked; outer apical cell longer than broad, pentagonal, not attaining wing apex.

Genital capsule: male plate *with oblique double row of macrosetae on disc*, in lateral view with small group of microsetae near lateral margin on basal half, and irregularly arranged smaller microsetae over apical half; pygofer, in lateral view, with group of submarginal macrosetae paralleling dorsal margin preapically, two smaller setae within ventrolateral margin and small group of microsetae just dorsad of outer basal angle of male plate; pygofer hook arising from posterior lobe of pygofer, directed dorsocaudad.

Internal male genitalia: style narrowed basally and apically, broadened on middle half its length, preapical lobe well developed, apex narrowed and directed posterolaterally, obliquely truncate apically; connective Y-shaped, the aedeagal articulation terminal; aedeagus with elongate preatrium, shaft long, slender, curved in large arc, the apex directed cephalad above the dorsal apodeme; dorsal apodeme with pair of flattened divergent processes, aedeagal shaft lacking processes.

The anterior margin of the head, in dorsal aspect, is paraboloid,

the median length exceeding the distance between the eyes. The head, including the eyes, is narrower than the broadest portion of the pronotum. In lateral aspect, the crown is sharply rounded to the face, which is convex on its upper half. The pronotum is short and broad, the lateral margins strongly divergent posteriorly, the posterior margin scarcely emarginate. The width of the pleural portion of the pronotum exceeds the width of the ocellocular area.

The type species is from Cuba, and is the only species representing this genus seen by the writer.

Rabela tabebuiae (Dozier), 1927b: 260 *(Protalebra),* new combination
bicincta Osborn, 1928a: 259 (*Protalebra*), new synonymy

Genus *Kallebra* McAtee

(Pl. 5, fig. 19; Pl. 6, fig. 20)

Protalebra (*Kallebra*) McAtee. Journ. N. Y. Ent. Soc., vol. 34, p. 152. 1926, new status.

Type of the genus, *Protalebra ninettae* Baker, by original designation.

Hind wings: vein 1V branching from vein 2V near its base; submarginal vein present (its apical extent undetermined); posterior branch of R touching M_{1+2} preapically, then diverging, the two veins extending separately towards wing apex; vein Cu_2 confluent with submarginal vein at point much basad of apparent forking of vein Cu_1.

Fore wings: appendix not extending around wing apex; *only three apical cells present* (probably as result of fusion of second and third apical veins); inner apical cell much longer than other two, the three apical cells, measured near mid-length of central one, approximately equal in width; outer apical cell subequal in length to central apical cell; cell M much broader than cell R.

Genital capsule: male plate, in ventral aspect, broad on basal half, outer margin strongly converging towards mesal margin on apical half to sharply rounded apex, with submarginal row of macrosetae paralleling lateral margin over third quarter of length, with basal lateral internal broad heavily-sclerotized thickening along lateral margin on basal half and extremely heavily sclerotized point at apex of thickening near middle of length of plate; in lateral aspect, plate with microsetae dispersed over apical half, plate extending as far distad as apex of pygofer; pygofer with submarginal group of few microsetae near ventral margin and few

macrosetae on disc; pygofer hook weak, arising from ventral pygofer margin and extending posteromesad.

Internal male genitalia: style, in lateral aspect, without preapical lobe, but with distinct apical extension, in dorsal aspect with obliquely truncate apex; connective membranous; aedeagus with well-developed dorsal apodeme giving off two slender elongate processes nearly as long as shaft, shaft slender, elongate slightly decurved apically; preatrium wanting.

The head is well produced medially, the median length greatly exceeding the width between the eyes, and nearly equal to that of the pronotum. In dorsal aspect, the anterior margin of the head appears nearly right-angled, with the apex rounded. The lateral margins of the pronotum are divergent posteriorly, and the posterior margin is shallowly concave. In lateral aspect, the face is smoothly and slightly convex, its contour strongly divergent from that of the dorsum. The width of the pleural portion of the pronotum exceeds the width of the ocellocular area.

The genus is known only from the type species, from Brazil.

Kallebra ninettae (Baker), 1899b: 403 (*Protalebra*)

Genus *Orsalebra*, nov.

(Pl. 6, fig. 21; Pl. 7, fig. 22)

Type of the genus, *Orsalebra robusta*, n. sp.

Hind wings: vein 1V branching from 2V near its midpoint; submarginal vein extending around wing apex and distinct from apical margin, continued beyond apex of posterior branch of R along costal margin towards base of wing, becoming evanescent near mid-costal margin; posterior branch of R separate from M_{1+2} apically, but connected with it by a preapical cross vein; vein Cu_1 apparently branched apically; vein Cu_2 attaining submarginal vein at point distad of vein m-cu.

Fore wings: appendix extending around wing apex; bases of first, second, and third apical cells transverse, these cells successively shorter towards costal margin; outer apical cell open at base; second apical cell with lateral margins subparallel; third apical cell broader apically than at base.

Genital capsule: male plate, in ventral aspect, broad basally, abruptly narrowed on outer margin at apical third, apex broadly rounded, disc of basal two thirds with sparse weak macrosetae, similar setae limited to mesal portion on apical third; pygofer in lateral aspect with middle of posterior margin produced posteriorly,

with sclerotized subquadrate thickening at its apex, with few macrosetae on posterior portion of disc before apical sclerotization and small group of microsetae near center of disc dorsad of outer basal angle of male plate.

Internal male genitalia: style elongate, slender, in lateral aspect with distinct preapical lobe and slender dorsal apical extension directed dorsomesad; connective U-shaped, the closed end dorsal, its plane forming right angle with plane of long axis of styles; aedeagal articulation on posterior face of closed end of connective; aedeagus in lateral view with elongate preatrium; in dorsal view with shaft curved gradually dorsad to near apex, then posteroventrad, extreme tip truncate, shaft broadly grooved on dorsal face from base to beginning of ventrally curved apical portion, the groove there replaced by dorsal carina retrorse at base, flanked by two similar lateral carinae, shaft with pair of laterally extending once-forked processes arising from its sides, each of the branches pectinate in appearance; in lateral view, the forked shaft processes arising just basad of an unpaired shaft process which lies closely appressed to the shaft apically and bears the three carinae already described; dorsal apodeme forked near tip, well developed.

This strange genus appears to be related to *Alebra* and has several characters which suggest an affinity with the Dikraneurini: the venation of the fore wings, the venation of the hind wings (except the unfused posterior branch of R and M_{1+2}) especially the position of the confluence of Cu_2 with the submarginal vein, and the apical extension of the styles. It may stand along the line, which leads to the Dikraneurini. Only the type of the genus is known, at present.

Orsalebra robusta, n. sp.

Form: General form broad, robust; head including eyes subequal in width to greatest width of pronotum, but little produced, median length of crown only small fraction of width between eyes, apex broadly rounded, crown broadly rounded to face; face in profile slightly concave above middle its length; ocelli present, slightly closer to eyes than to each other; pronotum broader than long, lateral margins divergent posteriorly, humeral angles broadly rounded, posterior margin shallowly emarginate, width of pleural portion of pronotum slightly exceeding width of ocellocular area; female sternite VII considerably produced medially, broadly convex laterally. Wings, male genital capsule and internal male genitalia as in generic description above.

Color: Dorsum pale yellowish white, a pair of faint spots around

each ocellus, three longitudinal discal pronotal vittae over basal two-thirds, basal angles of scutellum and apex except extreme tip, a claval vitta paralleling claval suture and a corial vitta parallel to this, a second corial vitta fainter and parallel to radial margin, pale yellow to orange; extreme tip of clavus and small portion of adjoining appendix deep, apex of brachial cell and bases of apical cells paler, black; face with suggestion of two yellow markings at base; remainder of venter stramineous except dark tarsal claws.

Described from male holotype and female allotype specimens from Hda. Talahua Bolivar, Ecuador, collected at an altitude of 3100 M. by F. M.- and H. H. Brown. Types in Snow Entomological Collections.

Genus *Balera*, nov.

(Pl. 7, fig. 23)

Type of the genus, *Dikraneura pellucida* Osborn.

Hind wings: submarginal vein present, distinct from apical wing margin, confluent with apex of posterior branch of R; posterior branch of R and M_{1+2} not confluent, vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein at point much basad of cross vein m-cu.

Fore wings: appendix not extending around wing apex; all apical cells much longer than broad, their bases angulate except inner apical cell which is oblique at base; inner apical cell much broader than other apical cells; third apical cell not stalked; *outer apical cell extending distad nearly to wing apex;* apex of cell M angulate, occurring opposite basal third of inner apical cell.

Genital capsule: male plate, in lateral aspect with group of macrosetae forming double row on disc of basal half, apical half with sparsely arranged microsetae; lateral margin near base with irregular row of microsetae; pygofer *without macrosetae on disc* but with a submarginal row of these occurring parallel to posterodorsal margin, a small group of microsetae on disc dorsad of outer basal angle of male plate; pygofer hook directed mesad, not differentially sclerotized.

Internal male genitalia: style, in lateral view, short, with distinct preapical lobe, apex curved dorsad with few setae along posterior margin then sharply ventrad, *the apical half of the style thus appearing sigmoid;* connective V-shaped, turned dorsad at extreme apex, the aedeagal articulation subterminal; aedeagus inflated, preatrium and dorsal apodeme weak, shaft keeled laterally, the keels widened apically forming pair of dorsolaterally extended membranous lobes, these continuous through a similar ventral

apical lobe extending distad from ventral margin of transverse gonopore.

The head, in dorsal aspect, is broadly triangular, with the apex obtusely angular. Its width, including the eyes, is greater than the width of the pronotum. The median length of the crown is subequal to the width between the eyes. In lateral aspect, the crown is rounded to the face, which is flat except for a slight concavity near its middle. The pronotum is narrow, the lateral margins subparallel, the posterior margin shallowly emarginate. The pleural portion of the pronotum is much wider than the ocellocular area.

The type of the genus is from Bolivia.

Balera pellucida (Osborn), 1928a: 271 *(Dikraneura),* new combination.

Genus *Diceratalebra,* nov.

(Pl. 7, fig. 24; pl. 8, fig. 25)

Type of the genus, *Alebra sanguinolinea* Baker.

Hind wings: vein 1V branching from vein 2V near its midpoint or slightly more proximad; submarginal vein present, confluent or not with apical wing margin; posterior branch of R and M_{1+2} fused for a short distance preapically or not, separate apically; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein at point basad of vein m-cu.

Fore wings: appendix present, extending around apex of wing *(interrogata)* or not; inner apical cell broad basally, much narrower on apical half; second apical cell narrow basally with lateral margins nearly parallel; third apical cell sessile or petiolate; outer apical cell short, not attaining wing apex, its length slightly exceeding its width; cell R extending more distad than cell M; cell M with oblique or obliquely angular apex.

Genital capsule: male plate, in ventral aspect, elongate, slender, gradually tapered to abruptly rounded apex, with single row of macrosetae over apical two thirds (middle two fourths in *robusta*), extending obliquely from disc distad to and along mesal margin; in lateral aspect with numerous irregularly arranged microsetae between these and lateral margin; pygofer produced posterodorsad, with single vertical row of macrosetae, and with group of microsetae just dorsad of outer basal angle of male plate; *pygofer hook arising along posteroventral margin or on disc near margin quite distant from base of male plate,* directed posteroventrad or posterodorsad.

Internal male genitalia: style short, without distinct preapical lobe or apical extension, curved slightly laterad at apex; connective heavily sclerotized and trapezoidal, or membranous; *aedeagus short, laterally compressed, appearing bifid at apex,* but with the dorsal ramus comprising the shaft and bearing the gonoduct, the ventral ramus actually a ventral process of the shaft.

The head is distinctly produced medially, with the apex rounded, in dorsal aspect. The median length of the crown is equal to, or exceeds, the width between the eyes, but is less than the median length of the pronotum. The lateral margins of the pronotum are sharply divergent posteriorly, and the posterior margin is shallowly concave. In lateral aspect, the contour of the face is convex, and strongly divergent from the line of the dorsum. The pleural portion of the pronotum is broader than the ocellocular area. Ocelli are present.

The genus is Neotropical in distribution.

Diceratalebra cubana (Osborn), 1928a: 261 *(Protalebra),* new combination
Diceratalebra interrogata (Knull), 1940b: 291 *(Alebra),* new combination
Diceratalebra sanguinolinea (Baker), 1903d: 5 *(Alebra),* new combination
Diceratalebra robusta (Gillette), 1898a: 712 *(Alebra),* new combination

Genus *Trypanalebra,* nov.

(Pl. 8, fig. 26)

Type of the genus, *Protalebra maculata* Baker.

Hind wings: vein 1V branching from vein 2V at its midpoint or more proximad; submarginal vein present, confluent with apical wing margin; posterior branch of R not confluent with vein M_{1+2}; vein Cu_1 appearing branched apically, the apparent forking near middle of wing; vein Cu_2 confluent with submarginal vein near middle of wing occasionally nearly opposite vein m-cu.

Fore wings: appendix not extending around wing apex; inner apical cell longer than second, not conspicuously wider at base than at apex; second apical cell slender, parallel-sided, in width equalling or exceeding inner apical cell; third apical cell trangular, petiolate or not at base; outer apical cell short, trapezoidal, not attaining wing apex, its width nearly or entirely equal to its length; cell R extending farther distad than cell M and expanded apically, its expanded apex usually in contact with all the apical cells; wing apex smoothly rounded.

Genital capsule: male plate, in ventral aspect, slender, gradually tapering to sharply rounded apex, with single row of macrosetae over apical two thirds, parallel to lateral margin, irregularly ar-

ranged except a close-set group at about basal third of length of plate; pygofer, in lateral aspect, with vertical or oblique row of macrosetae over disc, and small group of microsetae just dorsad of outer basal angle of male plate, posterior pygofer margin distinct, or poorly delimited from ventral margin; posterior pygofer margin inrolled and giving rise to short pygofer hook; anal hooks wanting.

Internal male genitalia: style short, without preapical lobe or conspicuous apical extension, in lateral aspect with apex decurved and acute; connective membranous; aedeagus laterally compressed, preatrium wanting, shaft short, directed posterodorsad, giving off pair of dorsal processes along its length; single median atrial process arising ventrally and extending far beyond apex of shaft.

The leafhoppers of this genus are small, and marked with yellow and black, and with a dark saddle across the middle of the dorsum. The head, including the eyes, is narrower than the pronotum. In dorsal aspect, the anterior margin of the head is broadly rounded. The distance between the eyes greatly exceeds the median length of the crown which is much less than the median length of the pronotum. The lateral margins of the pronotum are greatly divergent posteriorly, and the posterior margin is shallowly concave. The pleural portion of the pronotum is broader than the ocellocular area. Ocelli are present.

The genus is Neotropical and Sonoran in distribution. In addition to the genotype, the writer has examined an undescribed species from Arizona.

Trypanalebra maculata (Baker), 1903d: 6 *(Protalebra),* new combination

Genus *Paralebra* McAtee

(Pl. 9, fig. 27)

Protalebra (Paralebra) McAtee. Journ. New York Ent. Soc., vol. 34, pp. 147, 151. 1926, new status.
Protalebra (Plagalebra) McAtee. *op. cit.:* pp. 147, 150, 1926, new synonymy.

Type of the genus, *Protalebra similis* Baker, by original designation.

Hind wings: vein 1V branching from vein 2V basad of its midpoint; submarginal vein confluent with apical wing margin; posterior branch of R not confluent with vein M_{1+2}; vein Cu_1 appearing forked apically; vein Cu_2 confluent with submarginal vein near midpoint of wing, basad of cross vein m-cu.

Fore wings: appendix not extending around wing apex; inner apical cell much broader in basal half than at apex; second apical

cell longer than broad; third apical cell stalked, its apex scarcely attaining wing apex; outer apical cell short, trapezoidal, not attaining wing apex; cell R extending more distad than cell M; cell M simple or possessing a cross vein *(singularis)*.

Genital capsule: male plate, in ventral aspect, gradually narrowed to sharply rounded apex, in lateral aspect with oblique group of macrosetae over middle two fourths, with numerous irregularly arranged microsetae laterad and distad of these; pygofer with vertical row of discal macrosetae and group of microsetae near ventral margin, posterior margin produced or truncate, with ventral weak pygofer hook consisting of differentially sclerotized portion of pygofer wall, with or without additional digitate undifferentially-sclerotized process.

Internal male genitalia: style without preapical lobe or apical extension, its apex gently curved mesad or laterad; connective membranous; aedeagus with elongate heavily sclerotized atrial rim in form of inverted U, the dorsal closed portion expanded somewhat to form the apodeme, with pair of atrial processes arising dorsally or ventrally, extending laterad or parallel to aedeagal shaft; shaft elongate-campanulate, the apex turned slightly dorsad, without processes.

The head, in dorsal aspect, is well produced, rounded or angular at apex, with the crown flat or slightly concave. The pronotum is much broader than long, and broader than the head, including the eyes. The lateral margins of the pronotum are divergent posteriorly, and the posterior margin is concave. In lateral aspect, the contour of the face is flat or shallowly concave, and sharply divergent from the line of the dorsum. The pleural portion of the pronotum is much broader than the ocellocular area.

The genus has a Neotropical distribution. In addition to the species listed here, an undescribed Cuban species has been examined.

Paralebra similis (Baker), 1899b: 403 (*Protalebra*), new combination
Paralebra singularis (Baker), 1899b: 402 (*Protalebra*), new combination

Genus *Alebra* Fieber

(Pl. 9, fig. 28; Pl. 10, fig. 29)

Alebra Fieber. Katalog der Europäischen Cicadinen, p. 14. 1874.

Type of the genus, *Cicada albostriella* Fallén, by subsequent designation of Oshanin (Kat. Pal. Hemip., p. 111, 1912).

Hind wings: vein 1V branching from vein 2V near its midpoint; posterior branch of R not fused with vein M_{1+2}; vein Cu_1 appearing

branched apically; submarginal vein extending around wing apex and confluent with extremity of posterior branch of R; vein Cu_2 confluent with submarginal vein opposite vein m-cu.

Fore wings: appendix present, extending around wing apex; first, second and third apical cells subequal in length, the first slightly wider than either second or third; outer apical cell open basally; pattern formed by bases of apical cells nearly an unbroken transverse line.

Genital capsule: male plate with fairly numerous macrosetae arranged in linear group along mesal margin, a small group of coarse short macrosetae on lateral margin on middle third, a close-set cluster of setae on dorsal face of apex of plate, several microsetae on disc and on lateral margin on apical half; pygofer, in lateral view, with bilobed posterior margin, the dorsolateral lobe short, bearing sparse short setae, the ventrolateral lobe longer and bearing an anteapical group of macrosetae and a few discal microsetae.

Internal male genitalia: style elongate, without preapical lobe or apical extension, with small lobate ventral extension slightly distad of articulation with connective, apex acute, smoothly and sharply curved ventrad; connective triangular, the aedeagal articulation terminal; aedeagus with preatrium distinct, atrium small, dorsal apodeme well developed, shaft elongate, slender, without ornamentation or processes, gonopore terminal; shaft asymmetrical in ventral aspect as result of curvature to one side; anal hooks and pygofer processes wanting.

The head, including the eyes, is narrower than the pronotum. The median length of the crown is less than the width between the eyes. The anterior and posterior margins of the crown are subparallel. In lateral aspect, the crown is broadly rounded to the convex face. The pronotum is long, greatly exceeding in length the median length of the crown. The lateral margins are divergent posteriorly, the posterior margin shallowly emarginate. The pleural portion of the pronotum is considerably wider than the ocellocular area.

The North American specimens of the type species which have been dissected revealed constant difference from an European specimen from Hungary, which agreed fairly well with a French specimen illustrated by Ribaut. Several North American specimens were dissected and found to be identical in structure of genital capsule and internal male genitalia. The specimen figured is one of the North American forms. In the European forms

(*vide* Ribaut 1936), the lower of the two posterior pygofer lobes arises further ventrad on the posterior margin, and the dorsal aedeagal apodeme is slightly different. It seems doubtful to the writer that such differences, though constant in the specimens studied, are indicative of specific differences between Palaearctic and Nearctic forms.

From the Western Hemisphere, only the type of the genus is known.

Alebra albostriella (Fallén), 1826a:54 (*Cicada*) (*fide* Oman)

Alebra dorsalis Gillette was examined and found to be non-typhlocybine. Dr. Oman kindly examined the type and stated that it belongs in Deltocephalinae, near the genus *Atanus*.

Genus *Brunerella*, nov.

(Pl. 10, fig. 30; pl. 11, fig. 31)

Type of the genus, *Brunerella magnifica*, n. sp.

Hind wings: vein 1V branching from vein 2V basad of its midpoint; submarginal vein present, *extending to wing apex and confluent with apex of vein* M_{1+2}; posterior branch of R represented by a long spur; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein considerably basad of vein m-cu.

Fore wings: appendix not extending around wing apex; first, second, and third apical cells slender and progressively shorter in that order, their margins subparallel; outer apical cell trapezoidal, not attaining wing apex; inner apical cell slightly wider than either second or third apical cell; cell M with apex transverse, occurring opposite basal third of inner apical cell.

Genital capsule: male plate, in ventral aspect, with diagonal row of macrosetae across distal portion of basal third, and a similar row along mesal margin nearly to apex, outer margin abruptly narrowed beyond basal third, then parallel to inner margin to rounded apex; in lateral aspect, plate with group of small submarginal setae slightly distad of outer basal angle, a row of stout microsetae near to and paralleling lateral margin over distal half, disc with sparse microsetae; pygofer, in lateral aspect, slightly emarginate posterodorsally and with well-produced posterior lobe, disc with a few preapical macrosetae and with short stout microsetae located above lower part of oblique posteroventral margin; pygofer hooks and anal hooks wanting.

Internal male genitalia: style, in broad aspect, biramous basally, the connective articulating between the arms, outer margin nearly

straight, slightly expanded preapically, inner margin bisinuate, then narrowing obliquely and slightly concavely to blunt apex; connective narrow, its anterior margin shallowly angulate at center, the aedeagal articulation membranous; aedeagal shaft with preatrium short (disregarding membranous articular portion), a pair of apodemes arising from lateral atrial margin, sharply curved dorsad and mesad; shaft simple, tubular, unornamented, without processes.

The head is short and robust, the eyes massive. Ocelli are present.

This genus is dedicated to Dr. S. C. Bruner, of the Department of Phytopathology and Entomology of the Cuban Ministry of Agriculture, who has been most co-operative and who has collected some specimens in the type series.

Brunerella magnifica, n. sp.

Form: Head, including eyes, subequal in width to greatest width of pronotum, in dorsal aspect with apex broadly rounded before eyes, scarcely produced, the median length of crown more than double width between eyes; in profile with crown broadly rounded to convex face, with ocelli on margin between eyes, not visible from above, nearly touching mesal margins of compound eyes; pronotum short, median length about half width, lateral margins slightly divergent posteriorly, posterior margin shallowly concave, pleural portion not broad but in width greatly exceeding narrow ocellocular area; scutellum broadly exposed; abdomen heavily sclerotized; female sternite VII gradually produced medially in rounded posterior projection, the posterior margin sinuate each side of this; male plates and female pygofer lacking conspicuous dark macrosetae. Wings, genital capsule, and internal male genitalia as in generic description.

Color: Crown of head ivory white, with an irregular orange "V" in center, the arms broadly touching the eyes; pronotum sanguineous, except posterior margin medially which is slate-gray, with dark border between red and gray portions laterally, pleural portion of pronotum red above lower extremity; scutellum greenish yellow, a slender dark transverse line just before extreme apex; fore wings pruinose, a pale brick-red streak along costa near base, an angulate broad sanguineous vitta, its apex directed mesad, in basal half of clavus, and contiguous red spot in adjacent corium, the posterior margin of both narrowly edged in black; apical half of clavus except extreme tip and inner half of adjacent corium amber, the corial portion continuing caudad, becoming fumose, and broadening to cover apical cells except few slate-gray fenestrae and brick-red apical veins; base of outer apical cell fumose next costal margin, face and

legs ivory; hind tibiae narrowly embrowned apically; female pygofer black with pale setae.

Holotype male, allotype female and paratype male from 30 miles east of Jalapa, Mexico, collected December 31, 1949 by Dr. R. H. Beamer, in Snow Entomological Collections. Eight male specimens examined from Almandares River near Havana, Cuba, collected December 11, 1931 by Dr. S. C. Bruner on *Bourreria succulenta*, in collection of Dr. Bruner.

The Cuban specimens differ in color to a considerable degree from the Mexican ones, although the genitalia appear identical. In the Cuban material, the red color of the anterior portion of the pronotum invades the more posterior gray portion in a large median tooth which extends nearly to the base of the pronotum, while the dark gray between the red and gray on the pronotum is more pronounced than in the Mexican form. The angular red markings of the anterior part of the fore wing are deeper red and more extensive, forming a deep red line across the basal fourth of the wing except hyaline areas, one adjoining scutellum on each wing, and one on each wing astride claval suture, this transverse line bordered behind with dark. The amber yellow of the central part of the wings extends completely across both wings nearly as far distad as the apex of the clavus. The wing apices are more deeply dark and the dark marking extends cephalad to include the tip of the clavus.

Genus *Habralebra,* nov.

(Pl. 11, fig. 32)

Type of the genus, *Protalebra nicaraguensis* Baker.

Hind wings: vein 1V branching from vein 2V near its base; submarginal vein present, nearly confluent with wing apex to apex of vein M_{1+2}; posterior branch of R not confluent with vein M_{1+2} (posterior branch of R evanescent apically in type species); vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein at point considerably proximad of vein m-cu.

Fore wings: appendix not extending around wing apex; first, second, and third apical cells elongate, slender, the inner longer than either the second or third; outer apical cell short, not attaining wing apex, *its base nearly opposite apex of cell R;* cell M with apex transverse and occurring distad of basal third of inner apical cell, wider apically than cell R.

Genital capsule: male plate with oblique single row of macrosetae over middle third its length, or more extensive, extending along

mesal margin apically to near apex of plate, microsetae arranged variously; pygofer, in lateral aspect, with posterior margin produced, with single row of macrosetae over disc and group of microsetae dorsad of basal third of male plate, *with ventral margin rolled mesad and often giving rise to posteriorly directed pygofer hook;* anal hooks wanting.

Internal male genitalia: style various in form, apex curved gradually laterad; connective papilionaceous, Y-shaped, or occurring as a cross-bar, the apical portion occasionally turned dorsad, the aedeagus then joined to connective by a membranous connection; aedeagus, in lateral view, with elongate preatrium or none, dorsal apodeme well developed, Y- or T-shaped, *atrium giving rise to single ventral process which is thicker than apical half of long tapering shaft.*

The head, including the eyes, is narrower than the pronotum, and deltoid. In dorsal aspect, the median length of the crown exceeds the distance between the eyes. In lateral aspect, the crown is sharply rounded to the face. The pronotum, in dorsal aspect, has the lateral margins slightly divergent posteriorly and is smoothly concave on the posterior margin. The width of the pleural portion of the pronotum very greatly exceeds the width of the ocellocular area. The species examined are pale in color, with dorsal markings of pale yellow and black.

The genus has a Neotropical distribution. It seems to be closely related to *Elabra.*

Several undescribed species from South America have style apices with a distinct preapical lobe and what appears to be an apical extension, the latter broad apically and suggestive of the condition found in *Zygina* in the Erythroneurini. One of the paratypes of *bifasciata,* erroneously designated, has style apices of this sort.

Habralebra amoena (Baker), 1899b: 404 (*Protalebra*), new combination
Habralebra bifasciata (Gillette), 1898a: 711 (*Alebra*), new combination
Habralebra nicaraguensis (Baker), 1903d: 6 (*Protalebra*), new combination
Habralebra trimaculata (Gillette), 1898a: 712 (*Alebra*), new combination

Apparently the type of the genus was described from a single female specimen from San Marcos, Nicaragua. This specimen, in the Pomona College collection, did not bear a type label. A series of specimens of this species, from Mexico, from the D. M. DeLong collection, was examined by the writer.

Genus *Elabra*, nov.

(Pl. 11, fig. 33; pl. 12, fig. 34)

Type of genus, *Protalebra eburneola* Osborn.

Hind wings: submarginal vein present, confluent with apical wing margin and with apex of posterior branch of vein R; posterior branch of R fused with vein M_{1+2} through part of its length or not, the two veins separate apically; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein at point basad of vein m-cu.

Fore wings: appendix not extending around wing apex; inner apical cell broader or narrower than second apical cell; third apical cell trapezoidal or triangular, *not stalked;* outer apical cell short, not attaining wing apex, its base considerably basad of apex of cell R; *apex of cell M transverse, not oblique, occurring distad of basal third of inner apical cell.*

Genital capsule: male plate variable between species as to location of setae; pygofer with discal macrosetae, and group of microsetae on disc above outer basal angle of male plate, occasionally with macrosetae or microsetae on posterodorsal margin, and microsetae on posteroventral margin; pygofer hooks present or absent, median or dorsal in origin when present; anal hooks usually poorly developed.

Internal male genitalia: style without preapical lobe or apical extension, slender, tubular, straight or slightly curved at apex; connective in form of large cross-bar (except in *attenuata*); aedeagus with preatrium well developed or absent, *dorsal apodeme well developed* (except in *attenuata*); aedeagus often with pair of short ventral processes along its length.

The species included here are small and delicate in appearance, with elongate heads, the median length of the crown exceeding the distance between the eyes. The face, in profile, is slightly convex. The pleural portion of the pronotum is very broad, exceeding in width the ocellocular area.

The distribution is Neotropical.

Elabra attenuata (Osborn), 1928a: 269 (*Dikraneura*), new combination
albidula (Osborn), 1928a: 271 (*Dikraneura*), new synonymy
Elabra eburneola (Osborn), 1928a: 257 (*Protalebra*), new combination
Elabra parallela (Osborn), 1928a: 274 (*Dikraneura*), new combination
Elabra parana (Osborn), 1928a: 268 (*Dikraneura*), new combination
Elabra quadrifasciata (Osborn), 1928a: 272 (*Dikraneura*), new combination
Elabra sarana (Osborn), 1928a: 268 (*Dikraneura*), new combination

Genus *Rhabdotalebra,* nov.

(Pl. 12, fig. 35; pl. 13, fig. 36)

Type of the genus, *Protalebra octolineata* Baker.

Hind wings: vein 1V branching from vein 2V near its midpoint; submarginal vein confluent with apical wing margin; posterior branch of R fused with M_{1+2} for a short distance preapically or not, the two veins always separate apically; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein near mid-length of wing, much basad of cross vein m-cu.

Fore wings: appendix not extending around wing apex; inner apical cell much broader at base than at apex, longer than other apical cells; second apical cell angular at base (except in *brunnea*); third apical cell petiolate, scarcely attaining wing apex; apex of cell M opposite basal third of inner apical cell.

Genital capsule: male plate, in ventral aspect, slender, gradually tapered, with macrosetae over apical two thirds, or on basal half, their arrangement not uniseriate, in lateral aspect with microsetae irregularly arranged on distal two thirds of plate; *pygofer lacking macrosetae on disc, but with submarginal group near posterodorsal margin,* with microsetae dispersed on disc; posteroventral margin of pygofer inrolled and thickened to form pygofer hook which projects posterodorsad.

Internal male genitalia: style broadened near middle of its length, with apical median extension curved slightly laterad, preapical lobe well developed or not; connective heavily sclerotized; aedeagus lacking basal or atrial processes, shaft simple, occasionally with paired terminal processes, preatrium well developed, *apodeme saddle-shaped in lateral aspect,* elongate in axis of base of aedeagal shaft.

In dorsal aspect, the head including the eyes, is narrower than the pronotum, and distinctly produced medially to the rounded apex. The median length of the crown is slightly greater than the median length of the pronotum (exception: *octolineata*). The lateral margins of the pronotum are divergent posteriorly and the posterior margin is shallowly concave. In lateral aspect, the face is slightly convex, its contour sharply divergent from the line of the dorsum. Ocelli are absent.

The genus is Neotropical.

Rhabdotalebra brunnea (Oman), 1937d: 567 (*Protalebra*), new combination
Rhabdotalebra octolineata (Baker), 1903d: 7 (*Protalebra*), new combination
Rhabdotalebra signata (McAtee), 1926b: 148 (*Protalebra*), new combination, new status.

Genus *Protalebra* Baker

(Pl. 13, fig. 37)

Protalebra Baker. Psyche, vol. 8: pp. 401, 402. 1899.

Type of the genus, *Alebra curvilinea* Gillette, by original designation.

Hind wings: vein 1V branching from vein 2V near its midpoint or more basad; submarginal vein present, extending around wing apex, confluent with apical wing margin or not, its apex joining apex of posterior branch of R; posterior branch of R confluent with M_{1+2} for a short distance or not; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein at point basad of vein m-cu.

Fore wings: appendix not extending around wing apex; first and second apical cells of various forms, the first longer than the second; third apical cell sessile and quadrangular, triangular, or petiolate; outer apical cell short, not attaining wing apex.

Genital capsule: male plate variable as to arrangement of setae; pygofer with group of macrosetae on disc not limited to narrow area along posterodorsal margin; pygofer hooks ventral, posteroventral, or posterior in origin.

Internal male genitalia: style of varied form, usually short, and without preapical lobe or apical extension; connective sclerotized; aedeagus of various forms, preatrium usually well-developed, dorsal apodeme long or short, aedeagal shaft without processes.

At present, this genus is heterogeneous. It includes a considerable variety of forms, as well as those species which have not been studied, or only the females of which have been studied. In the list which follows, the species which have not been studied are prefixed with a single asterisk, while those for which no males have been studied are prefixed with a double asterisk.

*Protalebra apicalis Van Duzee, 1907a: 74
*Protalebra aureovittata (DeLong), *in* Wolcott 1923b: 267 (*Alebra*) *pallida* Osborn, 1928a: 260
*Protalebra cordiae Osborn, 1929b: 102
Protalebra curvilinea (Gillette), 1898a: 710 (*Alebra*)
Protalebra decorata (Osborn), 1928a: 255 (*Alebra*), new combination
**Protalebra lenticula Osborn, 1929b: 103
*Protalebra lineola Osborn, 1928a: 263
**Protalebra nexa McAtee, 1926b: 150
Protalebra omega Van Duzee, 1907a: 75
**Protalebra picea Osborn, 1928a: 265
*Protalebra sabana Osborn, 1928a: 259
*Protalebra scriptozona Van Duzee, 1923a: 186

**Protalebra sublunata (Osborn), 1928a: 289 (*Erythroneura*), new combination
*Protalebra transversalis Baker, 1903d: 6
Protalebra vexillifera Baker, 1899b: 404

Genus *Protalebrella*, nov.

(Pl. 13, fig. 38; pl. 14, fig. 39)

Type of the genus, *Protalebra brasiliensis* Baker.

Hind wings: vein 1V branching from vein 2V near its midpoint; submarginal vein present, confluent with wing margin at apex; posterior branch of R confluent with vein M_{1+2} for a short distance preapically but separate at apex, or not so confluent; vein Cu_1 appearing branched apically, the apparent forking near middle of discal area; vein Cu_2 confluent with submarginal vein near mid-length of wing, occasionally nearly opposite vein m-cu.

Fore wings: appendix not extending around wing apex; base of inner apical cell not in contact with cell R; second apical cell shorter than inner apical cell, its width at mid-length equalling or exceeding width of adjacent part of inner apical cell; third apical cell triangular or petiolate; outer apical cell broad, short, not attaining wing apex; cells R and M subequal in width at their broadest preapical portions; wing apex obliquely truncate.

Genital capsule: male plate, in ventral aspect, elongate, slender, gradually tapered to sharply rounded apex, with macrosetae throughout its length arranged laterally along margin, or laterally and discally; in lateral aspect, plate with number of microsetae irregularly arranged near lateral margin; pygofer with small group of macrosetae extending from posterodorsal portion of disc to posterodorsal margin, with dispersed group of microsetae just dorsad of outer basal angle of male plate, these occasionally extending dorsad on disc; posterior pygofer margin truncate or produced; *pygofer hook dorsal in origin, internal, directed ventrad,* simple or bifid.

Internal male genitalia: style short, stout, without preapical lobe and without conspicuous hairs or setae; connective sclerotized, in form of cross-bar or "V"; aedeagus with preatrium well developed; shaft short, dorsal apodeme elongate, as long as shaft; shaft and apodeme simple, without processes.

The species of this genus are slender and elongate. The head is narrower than the pronotum. In dorsal aspect, the anterior margin of the head is rounded or subangulate. Except in the genotype, the median length of the crown exceeds the distance between the eyes.

The pronotum is long, its median length exceeding that of the crown. The lateral margins of the pronotum are sharply divergent posteriorly and the posterior margin is shallowly concave. In lateral aspect, the line of the face is convex and sharply divergent from the line of the dorsum. The pleural portion of the pronotum is broader than the ocellocular area.

The genus is Neotropical in distribution.

In addition to the species listed, an undescribed species from Mexico has been examined.

Protalebrella brasiliensis (Baker), 1899b: 405 (*Protalebra*), new combination
Protalebrella terminata (Baker), 1899b: 404 (*Protelebra*), new combination

TRIBE DIKRANEURINI

The tribe is characterized by the presence, in the hind wing, of a submarginal vein which extends around the wing apex beyond the apex of vein "R + M," then basad along the costal margin, although this character is not found in the genus *Typhlocybella,* where apparently the submarginal vein has been lost in an extreme reduction of wing venation. Coupled with this character, except as noted below, is a characteristic development of the style apex which displays a distinct preapical lobe and a mesal apical extension. The extension may appear to arise as a uniform development from the preapical portion, so that there is no clear line of demarcation at its base; or it may arise from the dorsal region of the apex of the preapical portion of the style, and possess a clear line of demarcation at its base; or it may arise from the dorsal face of the style in the region anterior to the preapical lobe. The apical extension is never broad and truncate as in *Zygina,* and there is never a second extension from it as in *Erythroneura.* The extension is conical or cylindrical.

The male plates characteristically possess an oblique group of few macrosetae. The pygofer usually lacks macrosetae, but usually possesses small setae situated posterodorsally on the disc, or along the posterior margin. Pygofer hooks are frequently present, and most often arise dorsally, usually overhanging a posterior pygofer lobe.

The hind wings present evidence of considerable evolution within the tribe, with a tendency towards reduction in size, fusion of veins 1V and 2V, migration of vein Cu_2 towards the vannal fold and away from the apical half of the wing, and the fusion of the apex of vein Cu_1 with vein M_{3+4}. In the more primitive venation, veins 1V and 2V are separate apically, vein Cu_2 is confluent with the submarginal vein in the apical half of the wing, and vein Cu_1 is separate from vein M_{3+4} (Cu_1 appears branched) apically. This venation is found

in *Notus, Dicranoneura, Dikraneura,* and *Parallaxis,* but is not considered to indicate close relationship between these genera.

In the remainder of the genera, veins 1V and 2V are fused (except in *Hybla*), an occurrence which is unknown in any other Western Hemisphere Cicadellidae except in the closely related tribe Erythroneurini, which conceivably arose from dikraneurine stock. Coincident with the fusion of vannal veins, vein Cu_2 has migrated to a more basal position, resulting in a strengthening of the area of the hind wing weakened by the fusion of vannal veins. The fusion of vannal veins possibly arose twice in the Dikraneurini—once in the line of development leading to *Typhlocybella* (which appears closely related to *Parallaxis*), and again in the line leading to the *Dikrella* complex of genera (discussed below). Extreme reduction in hind wings with retention of both vannal veins is found only in the curious genus *Hybla.*

Further specialization of the wings, through reduction, occurs in the fusion of the apex of vein Cu_1 with vein M_{3+4} in *Idona, Typhlocybella,* and *Hybla,* genera which have too little else in common to validate this as a criterion of close relationship.

In each of the major groups mentioned above, those genera with two vannal veins and those with a single vannal vein, genera occur which lack a preapical lobe in the style. In the more generalized group (the retainers of both vannal veins), *Dicranoneura* and *Notus* exhibit this phenomenon. Whether the preapical lobe has been lost in these two genera, or whether it has never been present, is a matter for conjecture. Both of the genera possess curious additional morphological features. *Dicranoneura* has a membranous connective, a feature not found in other dikraneurine genera, but found in the more primitive Alebrini. *Dicranoneura* possesses, also, a thecate aedeagus. *Notus,* in addition to the unspecialized venation of the hind wings, has a paired ejaculatory duct, and a style broadly rounded apically suggesting a primitive condition antedating that of a mesal extension. However, the condition of both the style and the ejaculatory duct could be derived.

In the group of genera which have only a single vannal vein, *Sarascarta, Buritia,* and *Saranella* have styles which lack a preapical lobe. The reduced preapical lobe in *Neodikrella* (plate 24, fig. 64) suggests a possible loss of that structure in these genera, for the form of the styles and the connective in *Neodikrella* suggest an affinity with *Sarascarta* (plate 24, fig. 65).

The remainder of the genera form a complex already referred to as the "*Dikrella* complex." Included are *Dikrella, Alconeura, Donidea, Kidrella, Endoxoneura, Kunzeana, Dikrellidia* and *Idona.*

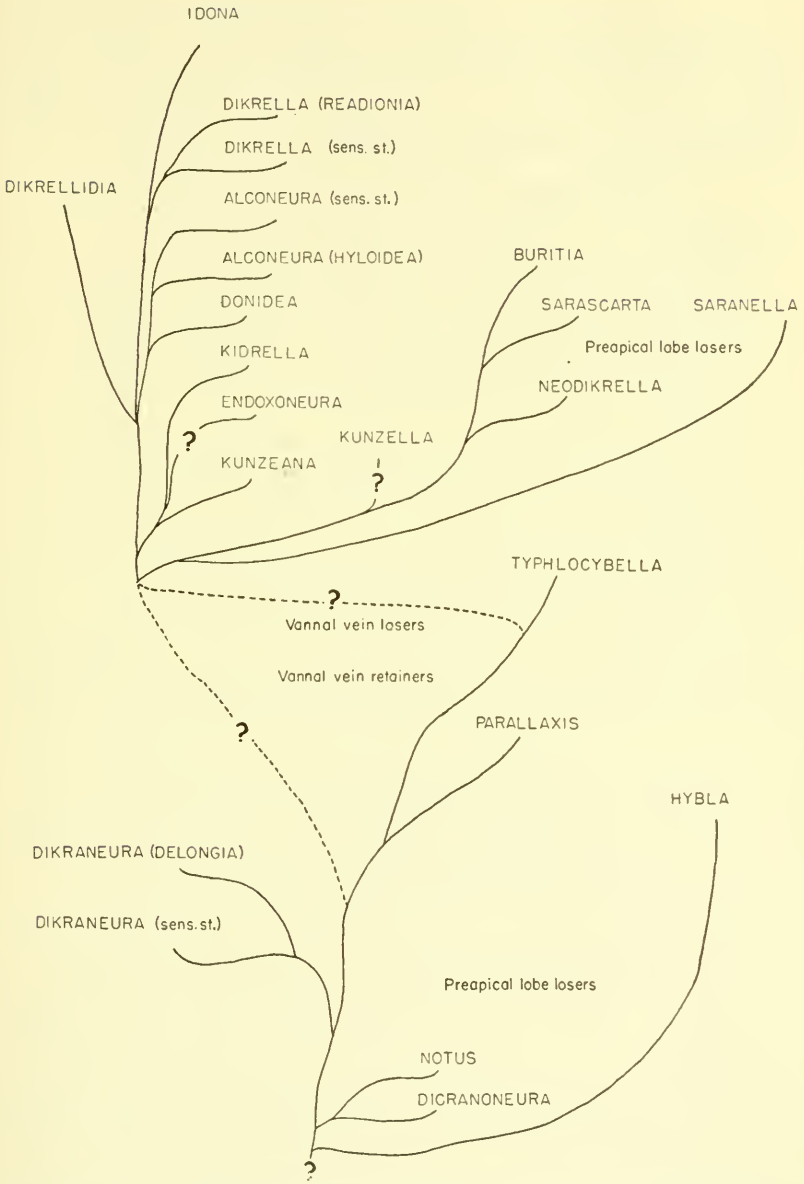

FIG. 1. Suggested relationships in Dikraneurini (the lines should be interpreted to have depth).

Hybla stands alone among the genera which retain both vannal veins, with a great reduction in venation of the hind wing, but with an unspecialized style.

The venation of the fore wings is quite plastic. There is a pronounced polyphyletic tendency for the third apical cell of the fore wing to become petiolate. The form of the third apical cell is variable, occasionally, even within genera. Occasionally the venation of the fore wing is of value taxonomically, as in *Kunzeana.*

KEY TO GENERA AND SUBGENERA OF DIKRANEURINI

1. Hind wing with vannal veins separate apically (plate 2, fig. 5) 2
   Hind wing with vannal veins fused throughout their length (plate 18, fig. 49a) 6
2. Male plates forcipate (plate 15, fig. 41); aedeagus thecate (plate 14, fig. 40e); connective membranous ..... *Dicranoneura*
   Male plates not forcipate; aedeagus not thecate; connective sclerotized 3
3. Male ninth sternum large, quadrate, length equalling or exceeding width; aedeagus with paired gonoducts; style apex without preapical lobe and apical extension, rounded (plate 15, fig. 42) ..... *Notus*
   Male ninth sternum not quadrate, broader than long; style apex with distinct preapical lobe and apical extension 4
4. All apical cells of fore wing conspicuously broadened to wing margin; third apical cell embracing entire wing apex (plate 17, fig. 47b) ..... *Parallaxis*
   All apical cells of fore wing with margins parallel; third apical cell not embracing entire wing apex (plate 16, fig. 44b), *Dikraneura,* 5
5. Vein Cu_2 of hind wing confluent with submarginal vein at point opposite vein m-cu; pygofer hooks present; connective U-shaped; preatrium poorly developed; inner apical vein of fore wing attaining wing margin (fig. 43, 44) ..... subg. *Dikraneura*
   Vein Cu_2 of hind wing confluent with submarginal vein at point basad of vein m-cu; connective not U-shaped; preatrium well-developed; inner apical vein of fore wing frequently not attaining wing margin (fig. 45) ..... subg. *Delongia*
6. Hind wing with vein Cu_1 appearing branched (plate 18, fig. 49a) 7
   Hind wing with vein Cu_1 appearing unbranched (plate 22, fig. 59a) 20
7. Fore wing with second apical cell elongate, slender, narrower than either adjoining apical cell (plate 18, fig. 49b) 8
   Fore wing with second apical cell of various shapes, but if elongate and slender, then exceeding in width either first or third apical cells 10
8. Connective Y-shaped, its apex extending more distad than style apex; mesal apical extension of style more than one-third length of that portion of style from connective to hind margin of preapical lobe; fore wing with second apical cell constricted at apex (fig. 63, 64) ..... *Neodikrella*

Connective Y-shaped or not, but with style apex always exceeding apex of connective; mesal apical extension of style less than one-third length of style from connective to hind margin of preapical lobe; fore wing with second apical cell broadened apically (fig. 49, 52) 9

9. Connective Y- or T-shaped; aedeagal apodeme of two conspicuous caliperate arms (plate 18, fig. 51) ..... *Kidrella*

Connective broadly U-shaped; dorsal aedeagal apodeme a transverse vertical plate, or if with conspicuous arms, then arms parallel or divergent, not caliperate ..... *Kunzeana*

10. Connective Y-shaped, the "stem" much longer than the "arms" and extending distad farther than the style apex; styles caliperate, without preapical lobes (plate 24, fig. 65d), *Sarascarta*

Connective Y-shaped or not, if Y-shaped, then "stem" subequal in length to "arms", rarely extending distad beyond style apex; styles not caliperate, with or without preapical lobes 11

11. Style apex with preapical lobe, with somewhat randomly arranged elongate fine setae extending from preapical lobe over apical extension uninterruptedly, or on apical extension alone and wanting on preapical lobe (fig. 54h, 55d, 56g), *Alconeura,* 12

Style with or without preapical lobe; if present, then setae absent, or present and shorter and occurring in groups, not extending from posterior lobe over apical extension 13

12. Form not extremely depressed dorsoventrally ..... subg. *Alconeura*

Form extremely depressed dorsoventrally ..... subg. *Hyloidea*

13. Style elongate slender, without preapical lobe or apical extension, with conspicuous ventrolateral basal lamella (plate 25, fig. 67d); fore wing with third apical cell stalked ..... *Saranella*

Style form varied, if elongate and slender, then without basal lamella; fore wing with third apical cell stalked or not 14

14. Fore wing with cells R and M extending distad to point nearly opposite apices of inner and outer apical cells; second and third apical cells with apical width equalling or exceeding length (plate 19, fig. 53b) ..... *Donidea*

Fore wing with cells R and M not extending distad to point nearly opposite apices of inner and outer apical cells; apical width of second or third or both apical cells less than respective length, 15

15. Style sickle-shaped in lateral aspect, with few small setae near base of curved portion (plate 25, fig. 66d) ..... *Buritia*

Style not sickle-shaped in lateral aspect, without setae near base, 16

16. Style short, very broad, with few long setae on apical extension; apex of connective exceeding style apex (plate 18, fig. 50d), *Endoxoneura*

Style apex greatly exceeding apex of connective 17

17. Style with conspicuous preapical lobe, not abruptly hooked at apex (plate 21, fig. 57g); pygofer hooks posterodorsal in origin or absent 18

Style without conspicuous preapical lobe, slender throughout, abruptly hooked at apex (plate 23, fig. 62d); pygofer hooks ventral in origin ..... *Kunzella*

18. Anal hooks present; aedeagal shaft with dorsal process arising from base (plate 22, fig. 60e) ..... *Dikrellidia*
    Anal hooks absent; aedeagal shaft without dorsal process arising from base ..... *Dikrella,* 19
19. Genital capsule not dorsoventrally flattened; male plates contiguous in unmacerated specimens, not exposing aedeagus between their mesal margins at their bases ..... subg. *Dikrella*
    Genital capsule dorsoventrally flattened; male plates not contiguous basally in unmacerated specimens, exposing aedeagus between their mesal margins at their bases (plate 22, fig. 58f), subg. *Readionia*
20. Hind wing with submarginal vein present at wing apex; third apical cell of fore wing not embracing entire wing apex 21
    Hind wing with submarginal vein absent at apex; third apical cell of fore wing embracing entire wing apex (plate 17, fig. 48a, b) ..... *Typhlocybella*
21. Pygofer hooks usually present; apical extension of style with setae 22
    Pygofer hooks present or absent; apical extension of style without setae ..... *Idona*
22. Pygofer hooks paired ..... *Endoxoneura*
    Pygofer hooks single or absent ..... *Alconeura* (*Hyloidea*)

Genus *Dicranoneura* Douglas

(Pl. 14, fig. 40; pl. 15, fig. 41)

Dicranoneura Douglas. Ent. Mo. Mag., vol. 12, p. 27. 1875.
Forcipata DeLong and Caldwell. Ann. Ent. Soc. Am., vol. 29 no. 1, p. 70. 1936 (type, *Forcipata loca* DeLong and Caldwell, by subsequent designation of DeLong and Caldwell in Ann. Ent. Soc. Am., vol. 35, p. 49. 1942), new synonymy.

Type of the genus, *Cicadula citrinella* Zetterstedt, by subsequent designation of Evans (Trans. Royal Ent. Soc. London, vol. 98 no. 6, p. 201. 1947).

Hind wings: vein 1V and 2V separate apically; submarginal vein present, extending around wing apex; posterior branch of vein R fused with vein M_{1+2} apically; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein at point opposite vein m-cu.

Fore wings: inner apical cell elongate, nearly attaining apical wing margin; second and third apical cells elongate, slender, successively shorter.

Genital capsule: ninth male sternum quadrate, with internal median longitudinal ridge and marginal ridge; plates narrow, forcipate, exposing aedeagus between their mesal margins, each plate with longitudinal row of prominent setae; pygofer hooks wanting; pygofer without distinct group of setae just dorsad of outer basal angle of male plate, with microsetae of variable location interspecifically.

Internal male genitalia: style narrow, gradually tapered to rounded apex, without preapical lobe or apical extension; connective membranous, connected apically with ventral portion of aedegal theca; aedeagus thecate (except in *magna*) on basal portion; genital atrium ventrally located.

The head, in dorsal aspect, is slightly produced medially, with the apex rounded. The pronotum is elongate, the lateral margins only slightly divergent posteriorly. The pleural portion of the pronotum is wider than the ocellocular area.

In unstained, cleared specimens, it is difficult to distinguish the delicate connective, and the aedeagus appears to be freely suspended in the genital capsule.

The name of this genus has long been considered to be an emendation of *Dikraneura*. That it may rightfully be considered to be so is open to grave doubt. The first use of the name did not clearly indicate that it was being used as an emendation, although it is quite clear from the original proposal that Douglas did consider it to be a partial synonym of *Dikraneura* Hardy and *Notus* Fieber. To the writer there seems as much reason to consider its first use as a separate proposal as to consider it as an emendation or as a substitute name. The names *Dikraneura* and *Dicranoneura* involve two separate Greek stems, and the fact that a "two-headed nerve" actually occurs in the hind wing of the species originally included (vein formed by preapical fusion of posterior branch of R with vein M_{1+2}, see figure 40a) suggests the idea that Douglas used the term by design, and not through an effort to emend *Dikraneura*.

The following species are included in this genus, from the New World. Only females of *acclina* were available for study.

Dicranoneura acclina (DeLong and Caldwell), 1936a: 74 (*Forcipata*), new combination

Dicranoneura ancantha (DeLong and Caldwell), 1936a: 73 (*Forcipata*), new combination

Dicranoneura lobata (Beamer), 1938d: 229 (*Forcipata*), new combination

Dicranoneura loca (DeLong and Caldwell), 1936a: 71 (*Forcipata*), new combination

Dicranoneura magna (DeLong and Caldwell), 1936a: 71 (*Forcipata*), new combination

Dicranoneura ohioensis (DeLong and Caldwell), 1936a: 73 (*Forcipata*), new combination

Dicranoneura ortha (DeLong and Caldwell), 1936a: 75 (*Forcipata*), new combination

Dicranoneura sicula (DeLong and Caldwell), 1936a: 72 (*Forcipata*), new combination

Dicranoneura triquetra (DeLong and Caldwell), 1936a: 72 (*Forcipata*), new combination

Genus *Notus* Fieber

(Pl. 15, fig. 42)

Notus Fieber. Verh. Zool. Bot. Ges. Wien, vol. 16, p. 507. 1866.
Dikraneura (*Curta*) DeLong and Caldwell. Proc. Ent. Soc. Washington, vol. 39 no. 2, p. 30. 1937.

Type of the genus, *Cicada flavipennis* Zetterstedt, by subsequent designation of McAtee (Proc. Zool. Soc. London, 114. 1934).

Hind wings: vein 1V branching from vein 2V near its midpoint; submarginal vein present, extending around wing apex, beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein at point opposite vein m-cu.

Fore wings: inner apical cell elongate, nearly attaining wing apex; third apical cell frequently wider than outer apical cell; outer apical cell frequently open basally; inner apical vein variable, attaining wing margin in some specimens, represented by spur in others.

Genital capsule: male ninth sternum as long as or longer than broad; plates short, strongly curved mesad, overlapping apically, with oblique row of macrosetae and with subterminal spine; pygofer without distinct group of setae just dorsad of outer basal angle of male plate; pygofer hook wanting; female seventh sternum interrupted medially, exposing underlying membrane.

Internal male genitalia: style without preapical lobe or apical extension, its apex broadly rounded; connective U-shaped in broad aspect; preatrium long; shaft and gonoducts paired.

The species of this genus are similar in general appearance to *Dicranoneura* and *Dikraneura.* In dorsal aspect, the head is produced medially, with the apex rounded or angular. The head, including the eyes, is broader than the pronotum. The pronotum is elongate, its lateral margins scarcely divergent posteriorly. In lateral aspect, the line of the face is divergent from the contour of the dorsum. The width of the pleural portion of the pronotum is equal to or greater than the width of the ocellocular area.

The following species from the Western Hemisphere have been studied and are included here.

Notus alta (DeLong and Caldwell), 1937a: 31 (*Dikraneura* (*Curta*))
Notus sitka (DeLong and Caldwell), 1937a: 31 (*Dikraneura* (*Curta*))

Genus *Dikraneura* Hardy

Dikraneura Hardy. Trans. Tyneside Nat. Field Club, vol. 1, p. 423. 1850.
Chloroneura Walsh. Prairie Farmer, New Series, vol. 10, no. 10, p. 148. 1862. (Type, *Chloroneura abnormis* Walsh, by subsequent designation of McAtee in Proc. Zool. Soc. London, p. 97. 1934).
Dicraneura (*auctt.*) (emendation of *Dikraneura* Hardy).

Dikraneura (*Notus*) Fieber of DeLong and Caldwell. Proc. Ent. Soc. Washington, vol. 39 no. 2, p. 22. 1937.

Type of the genus, *Dikraneura variata* Hardy, by monotypy.

Hind wings: vein 1V branching from vein 2V near its midlength; submarginal vein extending around wing apex beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically; vein Cu_2 confluent with submarginal vein usually at point opposite vein m-cu.

Fore wings: first, second, and third apical cells much longer than broad, successively shorter towards radial margin; outer apical cell elongate, slender, nearly attaining wing apex.

Genital capsule: male plate, in ventral aspect, triangular, with oblique row of macrosetae extending to apex in some species, less extensive in others; pygofer with oblique row of setae along or parallel to posterodorsal margin, and with microsetae variously arranged; with or without pygofer hooks; anal hooks wanting.

Internal male genitalia: style short, with extremely broad preapical lobe which is frequently rolled dorsad, and with short mesal apical extension sharply rounded at apex; connective U- or Y-shaped; aedeagus with or without preatrium and with or without processes on shaft.

Erythria Fieber has been placed in synonymy with this genus by previous workers. It is not listed here as a synonym of *Dikraneura* because a study of the type of the genus, *Cicada aureola* Fallén, suggests the possibility that it and its European allies with short apical cells in the fore wing may represent a distinct segregate.

Liguropia menozzii Haupt, 1930, which is a synonym of *Dikraneura juniperi* Lethierry, 1876, and which is the type of *Liguropia* Haupt has not been studied by the writer, and hence this name is not placed in synonymy with *Dikraneura* Hardy at this time. Ribaut's (1936) figures of this species suggest that it might well be segregated from *Dikraneura.*

Dikraneura subgenus *Dikraneura* Hardy

(Pl. 15, fig. 43; pl. 16, fig. 44)

See references under generic heading for synonymy.

Type of the subgenus, *Dikraneura variata* Hardy, by monotypy.

Hind wings: as in generic description; vein Cu_2 is always confluent with submarginal vein at point opposite vein m-cu.

Fore wings: as in generic description; apical veins complete, not represented by spurs.

Genital capsule: male plate with oblique row of macrosetae ex-

tending nearly to apex, or less extensive; pygofer with hook arising from near middle of posterior margin and extending caudad or mesad, or if hook not distinctly produced, then posterior margin of pygofer thickened and heavily sclerotized, posterodorsal margin with group of small setae basad of pygofer hook, microsetae frequently present, arranged irregularly over disc.

Internal male genitalia: connective U-shaped in vertical plane at right angles to long axis of styles, each of the arms giving rise to a dorsally directed short process; aedeagus usually without preatrium, with shaft processes usually present; otherwise as in generic description.

The species included here are elongate and slender, and some shade of green or yellow, occasionally marked with red or rufous. The head is well produced and angulate. The median length of the pronotum greatly exceeds the median length of the head. In lateral aspect, the contour of the face is sharply divergent from the line of the dorsum. The pleural portion of the pronotum is usually narrow, not greatly exceeding in width the ocellocular area. Ocelli are absent.

The subgenus is Holarctic and Sonoran in distribution. The following species from the Western Hemisphere have been studied and are included here:

Dikraneura abnormis (Walsh), 1864a: 316 (*Chloroneura*)
Dikraneura absenta DeLong and Caldwell, 1937a: 28
Dikraneura angustata Ball and DeLong, 1925a: 328
Dikraneura arcta DeLong and Caldwell, 1937a: 29
Dikraneura arizona DeLong and Caldwell, 1937a: 26
Dikraneura carneola (Stål), 1858e: 196 (*Typhlocyba*)
Dikraneura communis (Gillette), 1898a: 718 (*Dicraneura*)
Dikraneura hungerfordi Lawson, 1930e: 39
Dikraneura latacephala Beamer, 1943a: 57
Dikraneura mali (Provancher), 1890a: 298 (*Erythroneura*)
Dikraneura retusa Beamer, 1943a: 55
Dikraneura robusta Lawson, 1930c: 41
Dikraneura rufula (Gillette), 1898a: 720 (*Dicraneura*)
Dikraneura serrata DeLong and Caldwell, 1937a: 24
Dikraneura torta DeLong and Caldwell, 1937a: 25
Dikraneura ungulata Beamer, 1943a: 55
Dikraneura urbana Ball and DeLong, 1925a: 329

Dikraneura subgenus *Delongia*, nov.

(Pl. 16, fig. 45)

Type of the subgenus, *Dikraneura luna* DeLong and Caldwell.

Hind wings: venation as in typical subgenus, but vein Cu_2 is confluent with submarginal vein basad of vein m-cu.

Fore wings: apical portion of wing as in typical subgenus, but both inner and outer apical veins usually reduced to spurs of variable length, both frequently failing to attain wing margin.

Genital capsule: male plate much as in generic description, but without macrosetae over apical half; pygofer without hook or thickening on posterior margin, posterior margin truncate, with oblique row of submarginal macrosetae basad of posterodorsal margin, and few microsetae along posterior margin and in group on disc dorsad of outer basal angle of male plate.

Internal male genitalia: style as in typical subgenus; connective T-shaped in ventral aspect, the aedeagal articulation subterminal; preatrium distinct, the atrium occurring at end of basal third of length of aedeagus.

The head, including the eyes, is broader than the pronotum, greatly produced medially, and subangulate at apex. In lateral aspect, the crown is sharply rounded to the smoothly convex face. The pronotum is strongly convex anteriorly and has very short lateral margins. The pleural portion of the pronotum is narrower than the ocellocular area.

Only the type of the subgenus, a Sonoran species, is known.

D. (Delongia) luna DeLong and Caldwell, 1937a: 24

Genus *Parallaxis* McAtee

(Pl. 16, fig. 46; pl. 17, fig. 47)

Parallaxis McAtee. Journ. New York Ent. Soc., vol. 34, p. 154. 1926.
Erythria Fieber of Baker, in part, Invertebrata Pacifica, vol. 1, p. 3. 1903.

Type of the genus, *Parallaxis vacillans* McAtee, which is a synonym of *Erythria donaldsoni* Baker, by original designation.

Hind wings: vein 1V present; *vein 2V very poorly developed;* submarginal vein present, extending around wing apex beyond apex of vein "R + M" thence basad along costal margin; vein Cu_1 appearing branched apically, *both of the apparent branches attaining submarginal vein basad of wing apex;* vein Cu_2 confluent with submarginal vein near midlength of wing, much basad of vein m-cu.

Fore wings: bases of first and second apical cells obliquely angulate, together forming an oblique jagged line from commisural margin to inner corner of third apical cell; third apical cell sessile, *embracing wing apex;* outer apical cell trapezoidal, not attaining wing apex; cells R and M broadened anteapically, occasionally with broadened portions cut off by adventitious cross veins to form anteapical cells, or partially cut off by vestigial adventitious cross veins.

Genital capsule: male plate, in ventral aspect with oblique single row of macrosetae over basal half of disc, in lateral aspect with number of small submarginal setae parallel to lateral margin over basal half, setae of apical half various; pygofer in lateral aspect with small group of microsetae just dorsad of outer basal angle of male plate, a small group of submarginal macrosetae basad of posterodorsal margin, and occasionally smaller setae posterodorsad of these; pygofer hook present or absent, usually posterodorsal in origin when present, weak or strong, occasionally bifid.

Internal male genitalia: style with conspicuous preapical lobe and apical extension, the latter elongate and rounded apically, or short and obliquely truncate, the aedeagal articulation variable interspecifically; aedeagus with preatrium well developed or short, dorsal apodeme well developed, aedeagal processes present at base or more distad on shaft.

The insects included here are usually predominantly dark in color, with a heavily sclerotized abdomen. The color of the dorsum is usually mottled green or yellowish, but may be gray or gray marked with brick red. The veins bordering the apical and preapical cells (when present) are conspicuously pale. The head, in dorsal aspect, varies from nearly parallel-margined to distinctly produced medially. The face, in profile, is smoothly convex. Ocelli are wanting. The pronotum has short lateral margins which are divergent posteriorly and a rectilinear posterior margin. The width of the pleural portion of the pronotum is subequal to the width of the ocellocular area.

The writer has examined the type series of *Erythria donaldsoni* Baker. The six specimens are in the Pomona College Collection, were collected by Baker, and are topotypic (Managua, Nicaragua). A female specimen from the series is here designated lectotype.

Six specimens of *Erythria guzmani* Baker, all topotypic, from the Pomona College Collection, are presumed to be the type series, but like the above, did not bear type labels. One of the series, a male (San Marcos, Nicaragua) is here designated lectotype.

The type of *Typhlocyba permunda* Stål was examined through the kindness of Dr. R. Malaise of the Riksmuseum of Natural History in Stockholm.

The genus is Neotropical in distribution.

Parallaxis donaldsoni (Baker), 1903c: 4 (*Erythria*), new combination
vacillans McAtee, 1926b: 154, new synonymy

Parallaxis guzmani (Baker), 1903c: 4 (*Erythria*), new combination
clathrata McAtee, 1926b: 157, new synonymy

Parallaxis ornata Osborn, 1928a: 266
Parallaxis permunda (Stål), 1862e: 56 (*Typhlocyba*)
Parallaxis respersa McAtee, 1926b: 156
Parallaxis tessellata McAtee, 1926b: 155

Genus *Typhlocybella* Baker

(Pl. 17, fig. 48)

Typhlocybella Baker. Invertebrata Pacifica, vol. 1, p. 3. 1903.

Type of the genus, *Typhlocybella minima* Baker, by monotypy.

Hind wings: vannal veins completely fused; submarginal vein absent at wing apex; posterior branch of R fused with vein M_{1+2} apically, the fusion vein not attaining the wing apex; apex of vein Cu_1 fused with apical portion of vein M_{3+4} so that vein Cu_1 appears unbranched apically; vein Cu_2 confluent with submarginal vein in basal half of wing.

Fore wings: third apical cell short, triangular, petiolate, *embracing entire wing apex;* bases of first and second apical cells together forming an irregular oblique line from commissural margin to base of petiole of third apical cell.

Genital capsule: plates finely pilose, with few basal macrosetae; pygofer with subterminal row of several macrosetae, and numerous irregularly arranged microsetae; apex of pygofer, in lateral view, occasionally with an emargination.

Internal male genitalia: style with single median elongate tapering apical extension, lacking hairs or setae; connective somewhat U-shaped with apex turned dorsad, the aedeagal articulation subterminal; preatrium short; aedeagal shaft flattened laterally, with pair of prominent processes separating from shaft subapically and extending dorsolaterally and single median dorsal apical process overhanging gonopore; dorsal aedeagal apodeme large.

The species are small with a subconically produced head. The head, including the eyes, is slightly wider than the pronotum. The pronotum is scarcely emarginate posteriorly. In profile, the line of the face is sharply divergent from the line of the dorsum. The margin between crown and face is rounded. Specimens are dull yellowish green, occasionally with darker markings.

The genus has a wide Neotropical distribution.

In addition to the species listed below, an undescribed species has been studied.

Typhlocybella minima Baker, 1903b: 3

Genus *Kunzeana* Oman

(Pl. 18, fig. 49)

Kunzeana Oman. Mem. Ent. Soc. Washington, no. 3, p. 83. 1949.

Type of the genus, *Dikraneura kunzei* Gillette, by original designation.

Hind wings: vannal veins completely fused; submarginal vein present, extending around wing apex beyond apex of vein "R + M" then basad along costal margin; veins Cu_1 and M_{3+4} separate apically (Cu_1 appearing branched apically); vein Cu_2 confluent with submarginal vein in basal half of wing, much basad of vein m-cu.

Fore wings: length of first, second, and third apical cells somewhat variable, their bases usually forming an irregular transverse line; *second apical cell distinctly narrower than either adjoining apical cell;* outer apical cell with length greatly exceeding width, apex not attaining wing apex; cells R and M with relative widths varying between species.

Genital capsule: male plate, in lateral aspect, broad, parallel-margined, with few macrosetae on disc near middle, usually in an oblique linear arrangement, with numerous microsetae irregularly arranged, usually with group of longer microsetae somewhere along lateral margin; pygofer with macrosetae lacking on disc, with few small setae on posterior lobe, and often with number of small microsetae arranged over disc; pygofer hook posterodorsal in origin, short, overhanging posterior pygofer lobe or situated internal to it, rarely with pygofer hook wanting.

Internal male genitalia: style, in dorsal aspect, with single median apical extension; in broad aspect with preapical lobe not sharply delimited, tapering to apical extension, provided with few setae on tapered portion; connective broadly U-shaped; *aedeagus with dorsal apodeme well developed, strongly sclerotized, occurring as a superior flattened plate, or as an H-shaped superstructure in anterior aspect, the dorsal arms always conspicuous,* atrial processes present or absent, simple or branched when present, shaft processes present or absent, occasionally branched when present; *preatrium wanting.*

The species included here are predominantly dull green in color, typically with the crown of the head, the narrow anterior portion of the pronotum, and the scutellum partly or entirely paler in contrast. In profile, the contour of the lower part of the face is usually subparallel to the line of the dorsum.

Two specimens of *Erythria deschoni* Baker, apparently the type series, although they did not bear type labels, were studied from the

Pomona College collection. One of the specimens had the abdomen missing, the other was a female. Both of the specimens lacked wings. The female specimen is here designated lectotype.

The genus is Sonoran and Neotropical in distribution. The species have been reported to feed upon Leguminosae. A number of undescribed species have been examined in addition to the species listed below:

Kunzeana aurulenta (Lawson), 1930c: 41 (*Dikraneura*), new combination
Kunzeana benedicti (Beamer), 1943a: 59 (*Dikraneura*)
Kunzeana curiosa (Beamer), 1943a: 83 (*Dikraneura*)
Kunzeana deschoni (Baker), 1903c: 5 (*Erythria*), new combination
Kunzeana furcata (Beamer), 1943a: 62 (*Dikraneura*)
Kunzeana kunzei (Gillette), 1898a: 721 (*Dicraneura*)
Kunzeana lenta (McAtee), 1926b: 160 (*Dikraneura*)
Kunzeana munda (Beamer), 1943a: 62 (*Dikraneura*)
Kunzeana myersi (McAtee), 1926b: 161 (*Dikraneura*)
Kunzeana rosea (Osborn), 1928a: 278 (*Dikraneura* (*Hyloidea*)), new combination
Kunzeana salicis (Beamer), 1943a: 63 (*Dikraneura*)
Kunzeana sandersi (Ball and DeL.), 1925a: 332 (*Dikraneura*)
Kunzeana tenera (Beamer), 1943a: 61 (*Dikraneura*)
Kunzeana texana (Beamer), 1943a: 61 (*Dikraneura*)

Of the species listed above, *sandersi* and *myersi* have not been seen by the author. Dr. Oman (1949) is followed, in placing these species in this genus.

Genus *Endoxoneura*, nov.

(Pl. 18, fig. 50)

Type of the genus, *Dikraneura* (*Hyloidea*) *splendidula* Osborn.

Hind wings: vannal veins fused; submarginal vein extending around wing apex; apical vein formed by fusion of posterior branch of R and M_{1+2} extending unbranched to submarginal vein near wing apex; vein Cu_1 confluent with submarginal vein at point proximad of bases of apical cells.[1]

Fore wings: inner and outer apical cells angulate basally, their bases more proximad than bases of second and third apical cells; second and third apical cells equal in length, their bases forming a continuous transverse line.

Genital capsule: male plate with an oblique group of macrosetae and numerous scattered microsetae; pygofer hook posterodorsal in origin and surmounting a more inferior similar hook representing

1. The hind wings of the type were fragmentary, and it could not be determined whether the apex of Cu_1 was separate or fused with the apical portion of vein M_{3+4}.

the usual lobe found in this position, the more ventral hook with small group of microsetae; lateral face of pygofer lacking setae.

Internal male genitalia: style short, broad, with median apical conical posteriorly directed extension bearing two elongate setae on lateral face; preapical lobe small, situated near mid-length of that portion of style from connective to apex of broader portion; with few small setae within oblique posterior margin of preapical lobe; connective Y-shaped, its apex exceeding style apices, and turned dorsad, the aedeagal articulation subterminal; aedeagus with preatrium short, dorsal apodeme poorly developed; shaft with two pairs of processes given off near apex; gonopore terminal.

The head, including the eyes, is broader than the pronotum, and triangular in dorsal aspect, produced medially with the apex rounded. The pronotum, in dorsal aspect, is large with lateral margins nearly parallel and posterior margin very shallowly concave. The pleural portion of the pronotum is broader than the ocellocular area. In lateral aspect, the anterior margin of the head is thick. The contour of the face is subparallel to the line of the dorsum.

In structure of the fore wing, connective, styles (including setae), and general form of aedeagus (except apodemes) this genus is similar to *Kidrella*.

The type of the genus is Neotropical.

Endoxoneura splendidula (Osborn), 1928a: 275 [*Dikraneura* (*Hyloidea*)]

Genus *Kidrella*, nov.

(Pl. 18, fig. 51; pl. 19, fig. 52)

Type of the genus, *Dikraneura santana* Beamer.

Hind wings: vannal veins fused; submarginal vein present, extending around wing apex beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically, vein Cu_2 confluent with submarginal vein near middle of length of wing, much basad of vein m-cu.

Fore wings: inner apical cell much wider than either second or third apical cells; first and second apical cells scarcely wider at apex than at base; third apical cell much wider at apex than at base; first, second and third apical cells elongate slender, attaining apical wing margin; outer apical cell quadrilateral, not attaining wing apex; cells R and M subequal in apical width.

Genital capsule: male plate, in lateral aspect, exceeding tip of pygofer, with oblique row of few macrosetae over second fourth, and row of microsetae on disc distad of these to apex of plate, few

microsetae near lateral margin of plate near middle of its length; pygofer with posterodorsal margin produced, without a posterior margin; posteroventral margin with few microsetae near its middle; pygofer hook arising internally on posterodorsal portion of disc, extending posterodorsad.

Internal male genitalia: style elongate, slender, with distinct preapical lobe and mesal apical extension obliquely truncate at apex and provided with few setae along extension; connective Y-shaped; aedeagus without preatrium, slender, elongate, with paired processes arising from shaft near base or near apex; apodeme consisting of a pair of caliperate arms arising from atrium.

The line of the face, in lateral aspect, is only slightly divergent from the line of the dorsum. The width of the pleural portion of the pronotum is much greater than the width of the ocellocular area. The crown is shallowly depressed medially, or occasionally with a median slight carina and a consequent slight depression next each lateral margin.

This genus is known only from Arizona and Puerto Rico (an undescribed species).

Kidrella santana (Beamer), 1936a: 7 (*Dikraneura*), new combination

Genus *Donidea*, nov.

(Pl. 19, fig. 53)

Type of the genus, *Typhlocyba verticis* Baker.

Hind wings: vannal veins fused; submarginal vein present, extending around wing apex, beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically, not fused apically with apex of vein M_{3+4}; vein Cu_1 confluent with submarginal vein at point much proximad of vein m-cu.

Fore wings: all apical cells subequal in length; apices of cells R and M much distad of bases of inner and outer apical cells; inner and outer apical cells quadrilateral; second apical cell trapezoidal; third apical cell greatly narrowed basally.

Genital capsule: male plate with oblique double row of macrosetae, with numerous dispersed microsetae; pygofer without macrosetae, with cluster of microsetae on posterior lobe; pygofer hook posterodorsal in origin, decurved, exceeding apex of pygofer, lying external to posterior pygofer lobe.

Internal male genitalia: style elongate, with small but distinct preapical lobe and median posteriorly directed extension bearing one or two setae; connective papilionaceous in outline, apex turned dorsad, the aedeagal articulation subterminal; preatrium short;

dorsal aedeagal apodeme laterally compressed, subquadrate, well developed; shaft with pair of short terminal posteriorly curved tapering processes, and pair of basally-arising tapering processes diverging caudolaterally from shaft, extending almost to tip.

The head is conically well produced, its median length approximately equal to that of the pronotum. The crown is convex, the lateral margins convex, in dorsal aspect, to the sharply rounded apex. The width of the head exceeds that of the pronotum. The lateral margins of the pronotum are short and subparallel, the posterior margin shallowly concave. In lateral aspect, the line of the face is almost parallel to the line of the dorsum. The pleural portion of the pronotum is broader than the ocellocular area.

A single specimen of the type species has been examined from the Pomona College collection, and compared with the type of *Dikraneura* (*Hyloidea*) *eburnea* Osborn.

The genus is known only from its type, a Neotropical species.

Donidea verticis (Baker), 1903d: 8 (*Typhlocyba*), new combination
eburnea (Osborn), 1928a: 276 [*Dikraneura* (*Hyloidea*)], new synonymy

Genus *Alconeura* Ball and DeLong

Alconeura Ball and DeLong. Ann. Ent. Soc. Am., vol. 18, p. 334. 1925.
Dikraneura (*Hyloidea*) McAtee. Journ. N. Y. Ent. Soc., vol. 34, p. 162. 1926, new synonymy.
Dikraneuroidea Lawson. Bull. Brooklyn Ent. Soc., vol. 24, no. 5, p. 307. 1929, new synonymy.

Type of the genus, *Alconeura rotundata* Ball and DeLong, by original designation.

Hind wings: vannal veins entirely fused; submarginal vein present, extending around wing apex, beyond apex of vein "R + M" then basad along costal margin; apical portion of Cu_1 free or fused with apical portion of vein M_{3+4} (vein Cu_1 appearing branched or unbranched); vein Cu_2 confluent with submarginal vein at point much basad of fusion of posterior branch of R with vein M_{1+2}.

Fore wings: outer apical cell short, its apex not attaining wing apex; third apical cell usually pedunculate, rarely triangular at base or sessile; inner apical cell broader than second apical cell.

Genital capsule: arrangement of setae on male plates greatly varied; pygofer without macrosetae on disc; pygofer hooks present or absent; anal hooks wanting.

Internal male genitalia: style with distinct preapical lobe and apical extension; *style apex with numerous elongate fine setae not occurring in close-set groups or tufts;* connective and aedeagus of varied form.

Alconeura subgenus *Alconeura* Ball and DeLong

(Pl. 20, fig. 54)

Alconeura Ball and DeLong. Ann. Ent. Soc. Am., vol. 18, p. 334. 1925.

Type of the subgenus, *Alconeura rotundata* Ball and DeLong, by original designation.

Hind wings: as in generic description.

Fore wings: inner apical cell broader than second apical cell; second apical cell slender, parallel-margined; third apical cell usually pedunculate, rarely triangular at base or sessile; outer apical cell short, broad, polygonal, not attaining wing apex.

Genital capsule: male plate, in lateral aspect, broad, parallel-margined to near broadly rounded apex, with single or double oblique row of macrosetae, with numerous microsetae; pygofer without distinct group of setae just dorsad of outer basal angle of male plate, with group of small setae along posterior margin; pygofer hooks present and prominent or reduced to heavily sclerotized rudiments, dorsal in origin or arising near middle of posterior margin.

Internal male genitalia: apical extension of style arising from dorsal face; style apex with numerous elongate fine setae somewhat randomly arranged; connective Y-shaped or modified but with Y-shaped thickening; aedeagus with preatrium very short or wanting, shaft usually laterally compressed, without processes or with processes from base of shaft or from ventral portion of atrial rim; aedeagal apodeme well developed.

This subgenus includes small delicate leafhoppers. The head, including the eyes, is narrower than the pronotum. The median length of the crown is usually equal to or greater than the distance between the eyes. The lateral margins of the pronotum are sharply divergent posteriorly. The pleural portion of the pronotum is broader than the ocellocular area. There is nearly always a dark spot in the third or fourth apical cell of the fore wing. The species are variable as to color markings, but a considerable group are pale, marked with orange, and with apical veins edged in black.

Most of the species are Neotropical and Sonoran.

The wings of the type of *Dikraneura* (*Hyloidea*) *flavida* Osborn are so badly damaged that wing characters cannot be verified.

Alconeura balli Beamer, 1934b: 17

Alconeura bisagittata (Beamer), 1943a: 63 (*Dikraneura*), new combination

Alconeura centrosemae (Oman), 1937d: 568 (*Dikraneura*), new combination

Alconeura cornigera Griffith, 1938a: 332

Alconeura derecta Griffith, 1938a: 325
Alconeura dodonana Beamer, 1934b: 17
Alconeura dorsalis (DeLong), 1924a: 67
Alconeura flavida (Osborn), 1928a: 277 (*Dikraneura* (*Hyloidea*)), new combination
Alconeura fulminea Lawson, 1930d: 44
Alconeura insulae Griffith, 1938a: 325
Alconeura languida Griffith, 1938a: 330
Alconeura lappa Griffith, 1938a: 327
Alconeura luculenta Griffith, 1938a: 331
Alconeura macra Griffith, 1938a: 327
Alconeura necopinata Griffith, 1938a: 318
Alconeura nudata Ball and DeLong, 1925a: 336
Alconeura obliquata (Osborn), 1928a: 270 (*Dikraneura*), new combination
Alconeura planata Ball and DeLong, 1925a: 337
Alconeura pseudo-maculata (Baker), 1903d: 8 (*Typhlocyba*), new combination
Alconeura pseudo-obliqua (Baker), 1903d: 9 (*Typhlocyba*), new combination
Alconeura quadrimaculata Lawson, 1930d: 45
Alconeura quadrivittata (Gillette), 1898a: 723 (*Dicraneura*)
Alconeura rotundata Ball and DeLong, 1925a: 335
Alconeura santaritana, new name for *beameri* Griffith, 1936 nec Lawson, 1929
Alconeura tricolor (Van Duzee), 1914a: 56 (*Dicraneura*)
Alconeura unipuncta (Gillette), 1898a: 718 (*Dicraneura*)

Alconeura subgenus *Hyloidea* McAtee

(Pl. 20, fig. 55; pl. 21, fig. 56)

Dikraneura (*Hyloidea*) McAtee. Journ. New York Ent. Soc. vol. 34, p. 162. 1926.
Dikraneuroidea Lawson. Bull. Brooklyn Ent. Soc., vol. 24, no. 5, p. 307. 1929.

Type of the subgenus, *Dikraneura* (*Hyloidea*) *depressa* McAtee, by original designation.

Hind wings: as in generic description.

Fore wings: inner apical cell angulate basally, broader than second apical cell, not attaining wing apex; third apical cell pedunculate; outer apical cell in form of trapezium or subtrapezoidal, its apex not attaining wing apex.

Genital capsule: male plate, in lateral aspect, elongate, greatly exceeding apex of pygofer, with discal macrosetae usually greatly reduced in size, other setae various, frequently with cluster or row of close-set setae along lateral margin, apex usually truncate or even notched; pygofer, in lateral aspect, slender, elongate, without discal macrosetae, posterodorsal margin usually giving rise to short acicular pygofer hook overhanging posterior lobe of pygofer which bears few posteriorly directed microsetae.

Internal male genitalia: style with mesal apical extension, long or short, rounded at apex and bearing setae which are usually

numerous and elongate, exceeding style apex, occurring both mesally and laterally on style when few in number; connective triangular to T-shaped with apex turned dorsad and aedeagal articulation subterminal; aedeagus varied, shaft usually laterally compressed.

The species are greatly flattened dorsoventrally. In profile, the line of the face is nearly parallel to the line of the dorsum. The crown of the head is ample, and well-produced medially. The pleural portion of the pronotum is broad, its width more than double that of the ocellocular area.

In addition to the named species, undescribed species have been examined from Mexico, Costa Rica, Cuba, and Peru.

Alconeura beameri (Lawson), 1929d: 307 (*Dikraneuroidea*), new combination

Alconeura depressa (McAtee), 1926b: 162 (*Dikraneura* (*Hyloidea*)), new combination

Alconeura montealegrei (Baker), 1903c: 4 (*Erythria*), new combination

The type series of *Erythria montealegrei* Baker has been examined. It consists of a male and a female specimen from Champerico, Guatemala, and a specimen with the abdomen missing from Managua, Nicaragua. The male, from Champerico, Guatemala is here designed lectotype. The specimens are in the Pomona College Collection.

Genus *Dikrella* Oman

Dikrella Oman. Mem. Ent. Soc. Washington, no. 3, p. 83, 1949.

Type of the genus, *Dicraneura cockerellii* Gillette, by original designation.

Hind wings: vannal veins fused; submarginal vein extending around wing apex, beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically (its apex not fused with apex of vein M_{3+4}); vein Cu_2 confluent with submarginal vein in basal half of wing, much basad of apparent forking of vein Cu_1.

Fore wings: first, second, and third apical cells successively shorter; inner apical cell nearly attaining wing apex, broader at base than at apex; second and third apical cells broader at apex than at base, the third rarely stalked; outer apical cell triangular or quadrilateral.

Genital capsule: male plate varied in form, with few macrosetae in an oblique linear arrangement over disc in macerated specimens; pygofer without macrosetae, with few small setae located postero-

dorsally along margin or submarginal; *pygofer hook dorsal* (along mesal pygofer margin) in origin, or wanting, extending caudad, mesad, or caudoventrad when present; anal hooks absent.

Internal male genitalia: style short, with well-developed preapical lobe and mesal apical extension, *with few fine setae on posterior margin of preapical lobe, and rarely with group of similar setae located on apical extension;* connective triangular, papilionaceous, V-shaped or Y-shaped in form; aedeagus quite variable in form, preatrium usually present, ventral processes paired or unpaired usually present, arising from preatrium, atrium, or shaft.

Dikrella subgenus *Dikrella* Oman

(Pl. 21, fig. 57)

See reference under generic heading.

Type of the subgenus, *Dicraneura cockerellii* Gillette, by original designation.

Wings: as in generic description.

Genital capsule: capsule not conspicuously flattened dorsoventrally; male plates, in ventral aspect, with mesal margins contiguous basally in unmacerated specimens, not exposing aedeagus between them, plates without a lateral scale-like extension from lateral margin in ventral aspect, in macerated specimens; pygofer without posterodorsally directed lobe, with small setae on posterodorsal portion of disc or along posterior margin; pygofer hooks present or absent, when present arising from mesal (dorsal) pygofer margin and extending caudad, mesocaudad, or caudoventrad within capsule wall, in form slender and acicular, rarely ramose.

Internal male genitalia: style with conspicuous preapical lobe and mesal apical extension, preapical broad portion frequently somewhat rolled along both margins, presenting a troughlike appearance in caudal aspect, and with few fine hairlike setae arising from apex of lateral rolled edge, or when style is flatter and not troughlike, from a bulla at lateral angle of preapical lobe, occasionally (*cockerellii* and an undescribed species) with few hairs in a group on apical extension, but never with continuous array of elongate hairs over preapical lobe and apical extension as in *Alconeura;* connective typically papilionaceous in outline, but occasionally modified to V- or T-shaped; aedeagus quite varied, with preatrium nearly always present (absent in two undescribed species), with ventral processes usually present and arising from preatrium, atrium or shaft.

The species are extremely small and delicate in form, and pale in color, occasionally marked with red. The apical cells of the fore wings frequently have clouded portions, but the distinct dark spot so characteristic of *Alconeura* is usually absent. The head is well produced medially, with the apex rounded. Its width, including the eyes, is nearly always less than the width of the pronotum. The pleural portion of the pronotum is usually conspicuously broader than the ocellocular area. In lateral aspect, the contour of the face is divergent from the line of the dorsum.

The subgenus is interesting from the standpoint that good specific characters occur in the form of the style apices, and in the form of the connective, as well as the aedeagus. In addition to the species listed below, thirteen undescribed species have been studied.

The subgenus is predominantly Neotropical and Sonoran in distribution, with a few Nearctic representatives.

Dikrella aegra (Beamer), 1936c: 55 (*Dikraneura*)
Dikrella affinis (Osborn), 1928a: 269 (*Dikraneura*), new combination
Dikrella albonasa (McAtee), 1926b: 160 (*Dikraneura*), new combination
Dikrella californica (Lawson), 1930e: 35 (*Dikraneura*)
var. imbellis (Lawson), 1930e: 37 (*Dikraneura*)
nevadensis (Lawson), 1930e: 38 (*Dikraneura*), new synonymy
Dikrella cockerellii (Gillette), 1895a: 14 (*Dicraneura*)
Dikrella cruentata (Gillette), 1898a: 717 (*Dicraneura*)
Dikrella debilis (McAtee), 1926b: 162 (*Dikraneura*)
Dikrella fumida (Osborn), 1928a: 276 (*Dikraneura* (*Hyloidea*)), new combination
Dikrella hamar (DeL. and Ross), 1950a: 87 (*Dikraneura*), new combination
Dikrella maculata (Gillette), 1898a: 716 (*Dicraneura*)
Dikrella mera (McAtee), 1924a: 76 (*Dikraneura*)
Dikrella pusilla (Lawson), 1930e: 37 (*Dikraneura*)

Of the above, no males were available for study in the cases of *mera* and the typical variety of *californica*. *Fumida* Osborn is placed here because of the great similarity in male genitalia to other species in this subgenus. The type had the wings so badly damaged that the venation could not be discerned.

Dikrella subgenus *Readionia*, nov.

(Pl. 22, fig. 58)

Type of the subgenus, *Dikraneura readionis* Lawson.

Wings: as in generic description.

Genital capsule: capsule compressed dorsoventrally; male plates, in unmacerated specimens, in ventral aspect, with mesal margins not contiguous at base, the aedeagus visible between their bases, approximate apically; in macerated specimens plate with lateral

scalelike excrescence and with two conspicuous macrosetae on disc near lateral margin; pygofer with lobe arising posterodorsally and directed dorsocaudad, with few microsetae on lobe and occasionally on disc of pygofer, pygofer hook arising along dorsal (mesal) margin, extending caudad or mesocaudad, within lateral pygofer wall.

Internal male genitalia: style rolled and trough-like preapically as in typical subgenus, with few elongate fine setae at apex of lateral rolled portion, and occasionally one or two along posterior margin of preapical lobe; mesal apical extension of style slender and usually truncate apically, lacking setae; connective papilionaceous; aedeagus with preatrium well developed and with single or paired ventral aedeagal processes arising from atrium or shaft.

The species of this subgenus are very similar in appearance to those of the typical subgenus, but are usually larger, and with much longer wings. The lower part of the face, in lateral aspect, is frequently parallel to the line of the dorsum.

The distribution is Neotropical and Sonoran.

This subgenus is dedicated to the late Professor Philip A. Readio, who unselfishly devoted much time to the earlier training of the writer, and whose enthusiasm and stimulating interest have ever been a pleasing memory.

Dikrella cedrelae (Oman), 1937d: 569 (*Dikraneura*), new combination
Dikrella readionis (Lawson), 1930e: 39 (*Dikraneura*), new combination

In addition to the species listed above, a number of undescribed species have been studied.

Genus *Idona* DeLong

(Pl. 22, fig. 59)

Empoasca (*Idona*) DeLong. U. S. Dept. Agr. Tech. Bull., no. 231, p. 50. 1931.

Type of the genus, *Empoasca minuenda* Ball, by original designation.

Hind wings: vannal veins fused; submarginal vein extending around wing apex beyond apex of vein "R + M" then basad along costal margin; *vein* Cu_1 *appearing unbranched apically* (its apical portion fused with apical portion of vein M_{3+4}); vein Cu_2 confluent with submarginal vein in basal portion of wing, much basad of fusion of posterior branch of vein R with vein M_{1+2}.

Fore wings: inner apical cell larger than other apical cells, scarcely attaining wing apex; second apical cell slender, sessile; third apical cell quadrangular or triangular, frequently petiolate;

outer apical cell short, trapezoidal, not attaining wing apex; first, second and third apical cells successively shorter.

Genital capsule: male plate, in ventral view, with sclerotized internal thickening along lateral margin, extending distad for a variable distance forming "shoulder" in lateral margin of a plate at apex of thickened portion (occasionally before its apex), the shoulder bearing one or more stout setae (macerated specimens), the basal portion of the lateral sclerotized thickening connected by a basal transverse internal ridge with style opposite articulation with connective; plate without macrosetae in linear series; pygofer usually with group of small setae located posterodorsally; pygofer hooks present or absent, posterior or posterodorsal in origin when present, usually simple but occasionally modified (bifid at apex or hairy in appearance).

Internal male genitalia: style with distinct preapical lobe and apical extension from mesal margin, directed posteriorly; style usually troughlike in caudal aspect as in *Dikrella;* posterior lobe with few fine setae, usually short, rarely long and extending to apex of apical extension of style; connective very variable interspecifically, Y-, U-, or V-shaped, or in the form of a cross bar, the aedeagal articulation subterminal; aedeagus with distinct preatrium; aedeagal shaft laterally compressed; with pair of aedeagal processes arising from preatrium, lower portion of atrial rim, or base of shaft.

The species included here are very small, delicate leafhoppers with diverse color patterns or without color patterns. The head is subconically produced with rounded apex, in dorsal aspect. The contour of the face is quite divergent from the line of the dorsum. The posterior margin of the pronotum tends to be subparallel to the anterior margin, leaving the scutellum broadly exposed.

The holotype of *Dikraneura* (*Hyloidea*) *hyalina* Osborn has been studied. It has hind wings with a venation corresponding to that described above. The fore wings are somewhat similar to other species in this genus, except that the third apical cell is not narrowed basally. The fore wings are subfalcate apically. It seems best to include this species here, provisionally, until males can be obtained for study. Unfortunately, its inclusion here forces the renaming of *hyalina* (Beamer), which is a secondary homonym.

The genus is represented by a number of species in addition to the described species listed below. In distribution it is Neotropical and Sonoran.

Idona aperta (Beamer), 1943a: 58 (*Dikraneura*), new combination
Idona beameri, new name for *hyalina* (Beamer), 1943a: 58 *nec* Osborn, 1928
Idona hyalina (Osborn), 1928a: 276 (*Dikraneura* (*Hyloidea*)), new combination
Idona minuenda (Ball), 1921a: 23 (*Empoasca*)
Idona rubens (Beamer), 1934b: 16 (*Dikraneura*), new combination
Idona sexmaculata (DeLong), *in* Wolcott, 1923b: 270

Genus *Dikrellidia*, nov.

(Pl. 2, fig. 8; pl. 22, fig. 60; pl. 23, fig. 61)

Type of the genus, *Dikraneura bilineata* Osborn.

Hind wings: vannal veins fused; submarginal vein present, extending around wing apex beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically (its apical portion not fused with apical portion of vein M_{3+4}); vein Cu_2 confluent with submarginal vein in basal half of wing, much basad of vein m-cu.

Fore wings: inner and outer apical cells trapezoidal, the greatest width of each equal to or exceeding combined width of second and third apical cells at their bases; second apical cell longer than third; preapical width of cell R exceeding adjacent width of cell M.

Genital capsule: male plate with oblique row of macrosetae and dispersed apical microsetae; pygofer surface lacking conspicuous setae; a pair of inverted U-shaped hooks arising as introversions, one on each side, from posterior face of basal portion of anal tube, their lumen broadest posteriorly and readily seen in caudal in view.

Internal male genitalia: style elongate, slender, with conspicuous preapical lobe and mesal elongate posteriorly-directed cylindrical extension obliquely truncate apically; connective very shallowly U-shaped, the apex turned dorsad, the aedeagal articulation subterminal; aedeagus with bulbous basal portion giving off pair of ventrolateral elongate terete sinuate processes; atrial rim thickly sclerotized and giving off single dorsal posteriorly-directed conical cuspidate apodeme which is curved distally.

The head is well produced medially, the apex of the crown angular in dorsal aspect. The median length of the crown greatly exceeds the width between the eyes. The width of the head, including the eyes, exceeds the width of the pronotum. The pronotum is short, with lateral margins distinctly divergent posteriorly and the posterior margin shallowly emarginate. In lateral aspect, the face is smoothly and slightly convex, and divergent from the line of the dorsum. The pleural portion of the pronotum is much broader than the ocellocular area.

Only the type of the genus, a Bolivian species, is known.

Dikrellidia bilineata (Osborn), 1928a: 270 (*Dikraneura*), new combination

Genus *Kunzella*, nov.

(Pl. 23, fig. 62)

Type of the genus, *Dikraneura marginella* Baker.

Hind wings: vannal veins fused; submarginal vein present, extending around wing apex, beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically (its apical portion not fused with apical portion of vein M_{3+4}); vein Cu_2 confluent with submarginal vein in basal half of wing, much basad of vein m-cu.

Fore wings: apical venation quite variable between species; inner apical cell rectilinear or angulate basally; bases of second, third, and fourth apical cells often forming a slightly oblique line; outer apical cell elongate and slender or short and nearly semicircular, not attaining wing apex.

Genital capsule: male plate with oblique group of macrosetae near base and numerous dispersed microsetae; pygofer without distinct macrosetae; *pygofer hook arising from internal part of lower pygofer wall, extending posterodorsad.*

Internal male genitalia: style without preapical lobe, but with apical extension strongly arched in broad aspect and without setae; connective narrow, subtrapezoidal; genital atrium near base of aedeagus, the preatrium short; shaft massive, laterally compressed, with several subterminal processes.

The species are similar in appearance to species of *Kunzeana*—dull green, but with contrastingly paler crown, narrow anterior margin of pronotum, and entire scutellum. The head is well produced medially, the apex subangulate in dorsal aspect. The head, including the eyes, is somewhat narrower than the pronotum. In lateral aspect, the contour of the face is slightly convex, and divergent from the line of the dorsum. The pleural portion of the pronotum is broader than the ocellocular area. The apical cells of the fore wing are subhyaline.

The distribution is Neotropical. One undescribed species has been studied.

Kunzella marginella (Baker), 1925a: 160 (*Dikraneura*), new combination
Kunzella russea (McAtee), 1926b: 160 *Dikraneura*, new combination

Genus *Neodikrella,* nov.

(Pl. 23, fig. 63; pl. 24, fig. 64)

Type of the genus, *Dikraneura* (*Hyloidea*) *disconotata* Osborn.

Hind wings: vannal veins fused; submarginal vein extending around wing apex beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically (its apical portion not fused with apical portion of vein M_{3+4}); vein Cu_2 confluent with submarginal vein in basal half of wing, much basad of vein m-cu.

Fore wings: wing apex falcate; greatest width of inner apical cell exceeding combined width of second and third apical cells; second apical cell narrowed distally.

Genital capsule: male plate with oblique row of macrosetae and numerous scattered microsetae, some short, some elongate and fine; surface of pygofer without macrosetae pygofer hook elongate, dorsal in origin, extending caudad, overhanging and exceeding narrow posterodorsal caudally directed pygofer lobe.

Internal male genitalia: style with elongate tapering apical extension directed caudad but curved slightly mediad posteriorly; length of apical extension subequal to that segment of style from connective to apical extension; preapical lobe with minute setae; connective Y-shaped, the stem elongate, extending more caudad than style apices, with preapical bulbous enlargement; aedeagus complex, a horseshoe-shaped accessory piece surrounding genital atrium at sides and beneath, the side portions greatly expanded, the ventral portion with an anteriorly directed lobe articulating with connective, a pair of elongate tapering dorsally curved processes arising from lateral expanded portions of accessory piece, and a second similar pair of processes arising ventrally from basal articular portion and extending parallel to above pair of processes; aedeagal shaft unornamented.

The head is considerably produced before the eyes. In lateral view, the margin between crown and face is not carinate, and the line of the face is subparallel to the line of the dorsum. The pleural portion of the pronotum is broader than the ocellocular area.

Neodikrella disconotata (Osborn), 1928a: 275 (*Dikraneura* (*Hyloidea*)), new combination

Genus *Sarascarta,* nov.

(Pl. 24, fig. 65)

Type of the genus, *Dikraneura* (*Hyloidea*) *fulva* Osborn.

Hind wings: vannal veins fused; submarginal vein extending

around wing apex, beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically (its apex not fused with apical portion of vein M_{3+4}); vein Cu_1 confluent with submarginal vein in basal half of wing, much basad of vein m-cu.

Fore wings: first three apical cells progressively shorter and narrower; base of inner apical cell angular; outer apical cell open at base.

Genital capsule: male plate with oblique basal group of macrosetae; pygofer without macrosetae, with microsetae on disc; pygofer hook massive, arising posterodorsally with dorsal lightly sclerotized supporting arm.

Internal male gentialia: styles caliperate apically, sinuately curved laterad basally, then mesad distally, *without apical extension or preapical lobe,* with few subapical setae located on outer margins; connective T-shaped, widened apically, with elongate stem, *apex exceeding style apices;* aedeagus laterally compressed, preatrium wanting; paired ventral atrial processes present or absent.

The head is slightly deflexed. In profile, the line of the face is subparallel to the line of the dorsum. The pleural portion of the pronotum is subequal in width to the ocellocular area. The pronotum is broadly emarginate posteriorly, leaving the scutellum broadly exposed.

The fore wings of both available specimens of the genotype were coriaceous to the degree that the venation could not be ascertained. The venation figured is that of a single undescribed Bolivian specimen from the U. S. National Museum collection.

In addition to the Bolivian specimen mentioned above, a second undescribed species from Argentina has been examined, and a third from Puerto Rico.

Sarascarta fulva (Osborn), 1928a: 277 (*Dikraneura* (*Hyloidea*)), new combination

Genus *Buritia,* nov.

(Pl. 25, fig. 66)

Type of the genus, *Dikraneura lepida* McAtee.

Hind wings: vannal veins fused; submarginal vein extending around wing apex beyond apex of vein "R + M" then basad along costal margin; vein Cu_1 appearing branched apically (its apical portion not fused with apical portion of vein M_{3+4}); vein Cu_2 confluent with submarginal vein much basad of vein m-cu.

Fore wings: inner apical cell quadrilateral, its apex not attaining wing apex; second apical cell angular at base, almost parallel margined, slightly longer at apex than at base; third apical cell triangu-

lar, embracing most of wing apex; outer apical cell nearly triangular, its apex not attaining wing apex.

Genital capsule: male plate, in ventral aspect, broad at base, gradually narrowed on outer margin over apical three-fourths to sharply rounded apex, with row of macrosetae along lateral margin over basal two-thirds; in lateral aspect, plate conspicuously flat, with apex turned sharply dorsad; pygofer, in lateral aspect short, with elongate parallel-margined projection from middle of posterior margin and more heavily sclerotized hook immediately ventrad of this, disc without macrosetae, with few irregularly arranged microsetae.

Internal male genitalia: style elongate, slender, gradually tapered to acute apex, without preapical lobe or apical extension, in lateral aspect with apical portion sickle-shaped, curved sharply dorsad near articulation with connective, then gradually ventrad towards apex, with few small setae on ventral margin near beginning of curved portion; connective broadly U-shaped with pair of dorsal preapical projections, the aedeagal articulation subterminal; aedeagus without processes, with well-developed preatrium, shaft dorsoventrally (anteroposteriorly) compressed; dorsal apodeme well developed, branched, each branch with an anterior and a posterior process.

The head is well produced, the median length of the crown slightly less than the distance between the eyes. The width of the head, including the eyes, is slightly greater than the width of the pronotum. The pronotum is much longer than the head, with lateral margins nearly parallel and posterior margin nearly straight. In lateral aspect, the surface of the crown and the pronotum form a continuous declivent surface. The anterior margin of the head is thick, and the line of the face flat, not greatly divergent from the line of the dorsum. The pleural portion of the pronotum is subequal in width to the ocellocular area.

The genus is named for the settlement of Buriti, in Matto Grosso, Brazil, which is near the collecting site of many of the known South American leafhoppers which bear the locality label, "Chapada, Brazil," according to Dr. John Lane, of the University of São Paulo.

Buritia lepida (McAtee), 1926b: 161 (*Dikraneura*), new combination

Genus *Saranella*, nov.

(Pl. 25, fig. 67; pl. 26, fig. 68)

Type of the genus, *Dikraneura* (*Hyloidea*) *micronotata* Osborn.

Hind wings: vannal veins fused; submarginal vein extending around wing apex, beyond apex of vein "R + M" then basad along

costal margin; vein Cu_1 appearing branched apically (its apical portion not fused with apical portion of vein M_{3+4}); vein Cu_2 confluent with submarginal vein in proximal half of wing, much basad of vein m-cu.

Fore wings: greatest width of inner apical cell subequal to combined widths of second and third apical cells; inner and outer apical cells broad basally; second apical cell with lateral margins sinuate and subparallel; third apical cell pedunculate; pattern formed by bases of apical cells transverse, bowed caudad at caudal margins of cells R and M.

Genital capsule: plate with prominent lobe on outer margin before apex and with lateral oblique row of macrosetae; pygofer lacking setae except near origin of pygofer hook; pygofer hook arising internally on posterodorsal lobe, in dorsal aspect the two hooks elongate, slender, crossed.

Internal male genitalia: style elongate, slender, parallel-margined with slightly decurved acute tip, *lacking apical extension but with posterolaterally directed flat basal truncate extension arising opposite articulation with connective and connected with outer basal angle of male plate;* style without macrosetae; connective Y-shaped with apex turned dorsad, the aedeagal articulation subterminal; aedeagus simple, without processes; preatrium short.

The crown of the head and the disc of the pronotum form a smoothly convex surface. The face, in profile, is flattened, its contour nearly parallel to that of the dorsum. The pronotum is scarcely emarginate behind. The pleural portion of the pronotum is narrower than the ocellocular area.

Saranella micronotata (Osborn), 1928a: 278 (*Dikraneura* (*Hyloidea*)), new combination

Genus *Hybla* McAtee

(Pl. 26, fig. 69)

Hybla McAtee. Journ. Dept. Agr. Puerto Rico, vol. 16 no. 2, p. 119. 1932.

Type of the genus, *Hybla maculata* McAtee, by original designation.

Hind wings: vein 1V branching from vein 2V basad of its midpoint; submarginal vein extending around wing apex beyond apex of vein "R + M" then basad along costal margin; apical portion of vein Cu_1 free, not connected at all with any portion of vein M_{3+4} which does not occur as a separate vein; vein Cu_2 confluent with submarginal vein in basal half of wing.

Fore wings: first, second, and third apical cells successively

shorter, slender, narrow, each narrower than outer apical cell; outer apical cell open at base, its apex almost attaining wing apex.

Genital capsule: male plate, in ventral aspect, slender, gradually tapering from base to sharply rounded apex; in lateral aspect exceeding apex of pygofer; with oblique row of macrosetae over basal half of plate near lateral margin and marginal row of smaller setae on lateral margin near base; pygofer slender, posterodorsal margin extended caudad in digitate process which is not differentially sclerotized; disc of pygofer with few small microsetae.

Internal male genitalia: style, in dorsal aspect, elongate, slender, gradually curved posterolaterad in apical half to extreme apex which is abruptly curved laterad, inner margin with slight preapical prominence, terminal margin obliquely truncate; connective Y-shaped, the apex turned dorsad, the aedeagal articulation subterminal, anterior portion with median ventral attachment to venter of ninth segment; aedeagus slender, elongate, with recurved slender apical process bifid at tip and pair of retrorse processes arising near preapical gonopore on posterior (ventral) margin; preatrium wanting; apodeme slender, distinct.

The leafhoppers have a well-produced head, with the median length of the crown subequal to the width between the eyes, in the males, and to the median length of the pronotum. In dorsal aspect, the anterior margin of the crown is bluntly angulate. The head, including the eyes, is broader than the pronotum. The pronotum is broader than long. In lateral aspect, the contour of the face is subparallel to the line of the dorsum. The pleural portion of the pronotum is much broader than the ocellocular area.

The genus is known only from the type of the genus, a Puerto Rican species.

Hybla maculata McAtee, 1932b: 119.

TRIBE ERYTHRONEURINI, nov.

In the tribe Erythroneurini are placed all those Typhlocybinae in which the vannal veins are fused, Cu_1 appears branched apically (its apical portion not fused with the apical portion of vein M_{3+4}), Cu_2 is confluent with the submarginal vein in the basal half of the wing, and in which the style apices are in one of two forms of development: first, a single flattened apical extension which is truncate apically (Pl. 3, fig. 9), and second a condition in which a second extension has developed from the outer apex of the first extention (Pl. 3, figs. 10-15). In the second condition, the mesal apex of the first extension is represented by the "heel".

In the present classification, all those leafhoppers with a single broad extension of the style apex are placed in the genus *Zygina*. This genus is a complex of considerable size and wide distribution and is doubtless destined to undergo considerable subdivision.

In the Western Hemisphere, species of *Zygina*, hitherto referred to as the "Western *obliqua* group" of the genus *Erythroneura*, are known to occur from northern California and Colorado to Central America. The writer has examined specimens of an undescribed species from Argentina. Matsumura has described species from the Orient, and while not too much weight can be attached to the generic placement, his figures for the wings (1931b) suggest an accurate placement. *Erythroneura zealandica* Myers from New Zealand has been examined and found to belong to the *Zygina* complex as defined above.

In both Europe and North America, species of a diversity of form will be placed in the genus *Zygina* as here defined. Some of the species are large and robust, as the *ceonothana* group of North America, and Ribaut's (1936b) *lunaris* group of Europe; while some from the Palaearctic fauna and some from the Nearctic fauna are as small and delicate in appearance as true *Erythroneura*. Most of the Western Hemisphere forms possess two pygofer hooks on each side of the pygofer, one arising from the dorsal (mesal) margin, the other from the posteroventral margin, and in this respect they are distinct from other *Zygina* species examined.

In Europe, the gap sundering *Zygina* from *Erythroneura* is a narrow one. The European *Erythroneura* of the (*parvula*) = *ribauti* group of Ribaut (1936b) approaches a condition which may have given rise to *Erythroneura* (*sens. lat.*). In the *ribauti* group, the style apices are distinctly modified through the incorporation of what is believed to be a second apical extension (although the writer was not able to distinguish a clear line of demarcation between first and second extensions in *E. ribauti*, the only species available for study from this group). Species of this group are robust, with the general facies of some European *Zygina* and Nearctic *Zygina* of the *ceonothana* group. The pygofer of *E. ribauti* has a "jointed" pygofer hook identical with Nearctic *Erythroneura* of the *obliqua* group, and the relationship is further strengthened by the occurrence of a basal ventral, aedeagal membranelike expansion so characteristic of the Nearctic *obliqua* group.

The second apical extension of the style, the presence of which distinguishes *Erythroneura* from *Zygina*, in general, appears to be an extremely plastic feature interspecifically in Nearctic *Erythro-*

neura. It appears to be constant in form in the Palaearctic *flammigera* group of Ribaut, where it appears as a small rounded lobe. There is a possibility that *Erythroneura*, as here defined, will eventually come to be known to be as complex as *Zygina.* The North American fauna has long been known to have four closely related groups. The *flammigera* group appears quite distinct, as does the *alneti* group from Europe, and is worthy at least of subgeneric rank. A paratype of *Zygina lubiae* China, from Sudan, the only African form studied, was dissected and found to have a very bizarre second apical extension of the style, quite distinct from anything seen in Palaearctic and Nearctic forms.

The writer has refrained from naming the Western Hemisphere *Zygina* groups, in spite of their distinctness from the type of the genus because not enough material was available from the Orient to establish discontinuity in variation.

The possible origin of the tribe is obscure. The writer has thought two hypotheses worthy of consideration. The first of these would

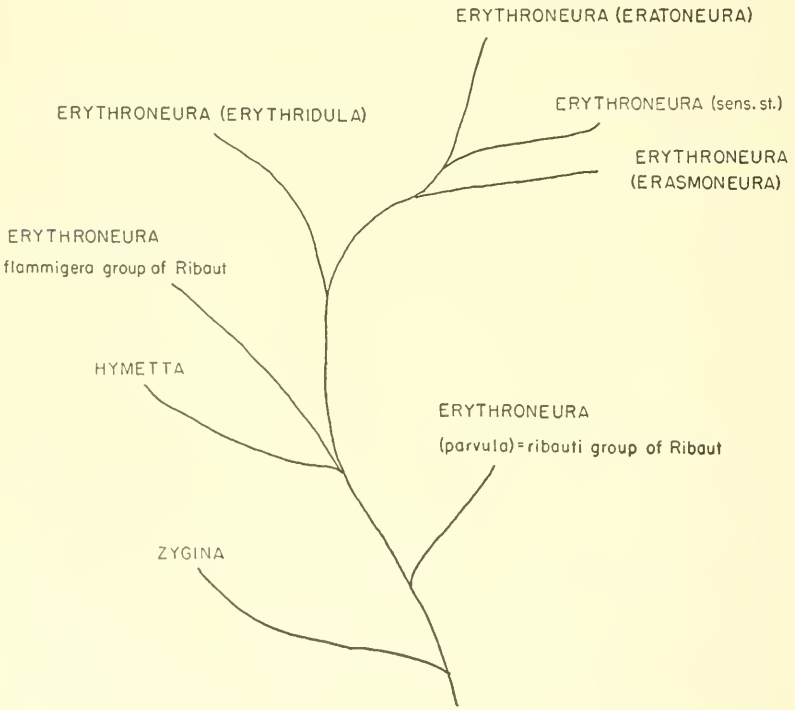

FIG. 2. Suggested relationships in Erythroneurini (the lines should be interpreted as having depth).

postulate an independent origin from the Alebrini, perhaps from Habralebralike ancestors. The extension of the style apex of an Ecuadorean species of *Habralebra* suggests a possible origin of the style pattern found in *Zygina*. An acceptance of such an idea would necessitate an assumption that a tremendous amount of parallel evolution in venation of the hind wings has occurred in the Erythroneurini and Dikraneurini.

The second, more plausible, possibility is that of an origin somewhere in dikraneurine stock, probably among the more specialized Dikraneurini where a single apical extension of the style, the fusion of vannal veins, the loss of the submarginal vein at the wing apex, and the migration of vein Cu_2 towards the base of the wing were already established.

The relationships which have suggested themselves as a result of morphological studies in the group are presented in "tree" form in the accompanying figure (text figure 2).

KEY TO GENERA AND SUBGENERA OF ERYTHRONEURINI

1. Style apex with single apical extension broad and truncate apically (plate 3, fig. 9) . . . . . *Zygina*
   Style apex with second extension or lobe of diverse forms developed from broad truncate first extension; "heel" present on style (plate 3, figs. 10-15) 2
2. Second apical cell of fore wing conspicuously broadened at apex (plate 27, fig. 72b) . . . . . *Hymetta*
   Second apical cell of fore wing narrow throughout, *Erythroneura* 3
3. Base of inner apical cell of fore wing transverse (plate 28, fig. 74b); pygofer hooks C-shaped (except in *tacita*) or modified C-shaped, the ventral arm of the C elongate or bifid (plate 27, figs. 73c, f; plate 28, fig. 74g) . . . . . *E. (Erythroneura)*
   Base of inner apical cell of fore wing oblique or angulate (plate 28, figs. 75b, 76b; plate 29, fig. 78b); pygofer hooks not C-shaped 4
4. Base of inner apical cell of fore wing oblique and angulate at confluence of vein Cu (plate 28, fig. 75b); pygofer hooks with narrow, basal, lightly-sclerotized jointlike region (except in *tecta*); pygofer with distinct group of setae just dorsad of outer basal angle of male plate (plate 28, fig. 75c) . . *E. (Erasmoneura)*
   Base of inner apical cell of fore wing oblique but not angulate at confluence of vein Cu (plate 28, fig. 76b; plate 29, fig. 78b); pygofer hooks without a narrow, jointlike basal portion, *or* if such a joint is present (plate 29, fig. 77f), then group of setae on pygofer just dorsad of outer basal angle of male plate is weak or vestigial (plate 29, fig. 77c) 5
5. Cu of fore wing confluent with base of inner apical cell near its outer basal angle (plate 29, fig. 78b); pygofer hooks slender

and elongate, simple or bifid, without a basal, lightly-sclerotized jointlike portion; pygofer with distinct group of setae just dorsad of outer basal angle of male plate (plate 29, fig. 78c); inner apical cell of fore wing usually with dark spot in base ..... *E.* (*Eratoneura*)

Cu of fore wing confluent with base of inner apical cell at point considerably mesad of its outer basal angle (plate 28, fig. 76b); pygofer hooks short, cuspidate, with basal lightly-sclerotized jointlike portion near their origin on mesal pygofer margin (plate 29, fig. 77f); group of vestigial setae (filiform under high magnification) on pygofer just dorsad of outer basal angle of male plate (plate 29, fig. 77c); inner apical cell of fore wing usually witihout a basal dark spot..... *E.* (*Erythridula*)

Genus *Zygina* Fieber

(Pl. 3, fig. 9; pl. 26, fig. 70; pl. 27, fig. 71)

Zygina Fieber. Vehr. zool-bot. Ges. Wien, vol. 16, p. 509, 1866.
Idia Fieber (*nec* Huebner). *loc. cit.* (type, *Typhlocyba scutellaris* Her.-Sch. (monobasic, the other included species being a synonym)).
Zyginidia Haupt (new name for *Idia* Fieber). Zool. Jahrb. (Abt. Syst.) vol. 58, p. 268. 1929 (type, *Typhlocyba scutellaris* Her.-Sch., by original designation).
Erythroneura Fitch, in part, of authors.

Type of the genus, *Typhlocyba nivea* Mulsant and Rey (monotypic).

Hind wings: vannal veins fused; submarginal vein absent at wing apex, confluent with apex of vein Cu_1 apically; posterior branch of R fused with vein M_{1+2}; vein Cu_2 confluent with submarginal vein in basal half of wing.

Fore wings: inner apical cell with base oblique to obliquely angulate, more proximad than base of second apical cell; second apical cell much narrower than either adjoining apical cell; third apical cell broad; outer apical cell short and small, not attaining wing apex.

Genital capsule: male plate, in ventral aspect, with oblique row of few microsetae over basal portion, in lateral aspect with submarginal row of microsetae, often stout; pygofer, in lateral aspect, *lacking macrosetae,* with microsetae variously arranged, frequently with distinct group of microsetae on disc dorsad of outer basal angle of male plate or dorsad of basal portion of lateral margin of male plate; pygofer hooks present, arising dorsally from the mesal margin, or ventrally from the posteroventral margin, or both (both usually present in Western Hemisphere species).

Internal male genitalia: style with distinct preapical lobe and single truncate flat apical extension, without second apical extension

(except in *kiperi*); connective U- or V-shaped, occasionally papilionaceous in form; aedeagus of varied form and with varied processes or without processes.

As pointed out earlier in the discussion under the tribal heading, the genus, as it now stands, is a large complex. The species are greatly variable in shape, from broad and robust to narrow and delicate. They are greatly variable in color markings. In *Z. kiperi*, the style exhibits a second extension, which from its form, is believed to be of origin independent from that which led to *Erythroneura*.

Oman (1949) has already pointed out that the North American species are capable of subdivision.

The following key will separate the Western Hemisphere species groups. An undescribed Argentine species belongs to the *ceonothana* group.

KEY TO GROUPS OF WESTERN HEMISPHERE ZYGINA

Broad robust leafhoppers; head in dorsal aspect with anterior margin broadly rounded, with two conspicuous black spots on crown; pleural portion of pronotum narrower than ocellocular area ..... *ceonothana group*

Less broad and robust; head more produced medially; spots on crown wanting or less pronounced; pleural portion of pronotum broader than ocellocular area ..... *ritana group*

Ceonothana group

Zygina albluta (McAtee), 1924d: 132 (*Erythroneura*), new combination
Zygina apacha (Baker), 1925b: 537 (*Erythroneura*), new combination
Zygina arida (Beamer), 1937b: 31 (*Erythroneura*), new combination
Zygina balli (Beamer), 1932i: 125 (*Erythroneuro*), new combination
Zygina bimaculata (Baker), 1903d: 9 (*Typhlocyba*), new combination
Zygina ceonothana (Beamer), 1934c: 287 (*Erythroneura*), new combination
Zygina davisi (Beamer), 1934d: 96 (*Erythroneura*), new combination
Zygina huachucana (Beamer), 1934c: 287 (*Erythroneura*), new combination
Zygina penapacha (Beamer), 1941a: 18 (*Erythroneura*), new combination
Zygina quadricornis (Beamer), 1930b: 431 (*Erythroneura*), new combination

Ritana group

Zygina ales (Beamer), 1932i: 124 (*Erythroneura*), new combination
Zygina aprica (McAtee), 1924d: 132 (*Erythroneura*), new combination
Zygina aucta (McAtee), 1920a: 279 (*Erythroneura*), new combination
Zygina bilocularis (Van Duzee), 1924a: 233 (*Erythroneura*), new combination
Zygina canyonensis (Beamer), 1929b: 120 (*Erythroneura*), new combination
Zygina casta (Beamer), 1929b: 118 (*Erythroneura*), new combination
Zygina cimarroni (Beamer), 1929b: 119 (*Erythroneura*), new combination
Zygina cornigera (Beamer), 1937b: 31 (*Erythroneura*), new combination
Zygina dentata (Gillette), 1898a: 765 (*Typhlocyba*), new combination

Zygina erosa (McAtee), 1924c: 36 (*Erythroneura*), new combination
Zygina grandis (Beamer), 1929b: 127 (*Erythroneura*), new combination
Zygina illinoiensis (Gillette), 1898a: 758 (*Typhlocyba*), new combination
Zygina inclita (Beamer), 1934a: 44 (*Erythroneura*), new combination
Zygina inornata (McAtee), 1924d: 132 (*Erythroneura*), new combination
Zygina kiperi (Beamer), 1929b: 124 (*Erythroneura*), new combination
Zygina merita (Beamer), 1932i: 127 (*Erythroneura*), new combination
Zygina milleri (Beamer), 1929b: 125 (*Erythroneura*), new combination
Zygina nicholi (Beamer), 1927a: 30 (*Erythroneura*), new combination
Zygina novella (Knull and Auten), 1938a: 536 (*Erythroneura*), new combination.
Zygina obscura (Beamer), 1929b: 117 (*Erythroneura*), new combination
Zygina oculata (McAtee), 1924e: 39 (*Erythroneura*), new combination
Zygina pallenta (Beamer), 1929b: 117 (*Erythroneura*), new combination
Zygina pinalensis (Beamer), 1929b: 119 (*Erythroneura*), new combination
Zygina ritana (Beamer), 1934c: 286 (*Erythroneura*), new combination
Zygina rubicunda (Beamer), 1929b: 126 (*Erythroneura*), new combination
Zygina tergemina (Van Duzee), 1924a: 235 (*Erythroneura*), new combination
Zygina ternaria (Van Duzee), 1924a: 232 (*Erythroneura*), new combination
Zygina triceroprocta (Beamer), 1929b: 118 (*Erythroneura*), new combination
Zygina tricolor (Beamer), 1929b: 124 (*Erythroneura*), new combination
Zygina tripunctata (Beamer), 1929b: 124 (*Erythroneura*), new combination
Zygina unicolor (Beamer), 1929b: 120 (*Erythroneura*), new combination
Zygina utahna (Beamer), 1937b: 32 (*Erythroneura*), new combination

The following species of *Zygina* have not been studied, and cannot, therefore, be placed in the appropriate grouping above.

Zygina agnata (Knull and Auten), 1938a: 537 (*Erythroneura*), new combination
Zygina arizonica (Knull and Auten), 1938a: 536 (*Erythroneura*), new combination
Zygina blanda (Knull and Auten), 1938a: 538 (*Erythroneura*), new combination
Zygina modula (Knull and Auten), 1938a: 535 (*Erythroneura*), new combination.
Zygina munda (Knull and Auten), 1938a: 534 (*Erythroneura*), new combination
Zygina nuda (Knull and Auten), 1938a: 538 (*Erythroneura*), new combination
Zygina sola (Knull and Auten), 1938a: 534 (*Erythroneura*), new combination
Zygina spectabilis (Knull and Auten), 1938a: 533 (*Erythroneura*), new combination

Genus *Hymetta* McAtee

(Pl. 27, fig. 72)

Hymetta McAtee. Proc. Biol. Soc. Washington, vol. 32, p. 121, 1919.

Type of the genus, *Tettigonia trifasciata* Say, by original designation.

Hind wings: as in *Zygina.*

Fore wings: inner apical cell broader at base than second or third apical cells, its base oblique or obliquely angulate; *second apical cell conspicuously wider at apex than at base;* third apical cell widened apically; outer apical cell short, quadrilateral, not attaining wing margin.

Genital capsule: male plate, in ventral aspect, narrowed on lateral margin near middle its length, apex rounded, with oblique row of few macrosetae over disc laterally on basal portion; in lateral aspect, plate with submarginal irregular row of microsetae parallel to lateral margin, and with number of irregularly arranged microsetae over distal half; pygofer, in lateral aspect, with group of small setae dorsad of outer basal angle of male plate, few smaller setae cephalad of posterior margin, and irregularly arranged microsetae; pygofer hook short, arising from mesal pygofer margin, extending mesad free from pygofer wall through most its length, its base without a jointlike, lightly-sclerotized portion.

Internal male genitalia: style with broad conspicuous preapical lobe and apical footlike extension, the "toe" apparently formed by a small second extension, preapical lobe with small group of discal microsetae; connective short, Y-shaped with stem turned dorsad, the aedeagal articulation subterminal; aedeagus with well developed preatrium, shaft surmounting and roughly parallel to pair of more ventral preatrial processes.

The species are robust. In dorsal aspect, the head including the eyes is narrower than the pronotum, and well produced medially to the rounded apex of the crown. The lateral margins of the pronotum are divergent posteriorly, and the posterior margin is shallowly concave. In lateral aspect, the line of the face is smoothly convex, and divergent from the line of the dorsum. The pleural portion of the pronotum is broader than the ocellocular area. The scutellum, in lateral aspect, is elevated posteriorly, a character which has been overemphasized heretofore, for its use in a key frequently leads to erroneous results. The species are beautifully marked with dusky bands on a cream-colored background and frequently with orange to red spots. The identity of the species is in a state of confusion, at present, and a revision is greatly needed.

This genus is closely related to *Erythroneura,* and has a distribution which is primarily Nearctic.

Hymetta anthisma McAtee, 1919a: 123.
Hymetta arizoniana Fairbairn, 1928a: 90

Hymetta balteata McAtee, 1919a: 123
distincta Fairbairn, 1928a: 87, new synonymy
Hymetta kansasensis Fairbairn, 1928a: 90
Hymetta trifasciata (Say), 1825a: 343 (*Tettigonia*) (*fide* Oman)

Genus *Erythroneura* Fitch

Erythroneura Fitch. Ann. Rep. New York St. Cab. Nat. Hist., p. 62. 1851.

Type of the genus, *Erythroneura tricincta* Fitch, by subsequent designation of Oshanin, 1912.

Hind wings: as in *Zygina.*

Fore wings: base of inner apical cell oblique, angulate, or transverse; vein Cu confluent with base of inner apical cell at a point varying from its center to its outer extremity; *second apical cell narrow, with sides subparallel;* third apical cell usually quadrilateral, rarely triangular; outer apical cell not attaining wing apex; bases of apical cells forming a variable pattern, together appearing nearly as a transverse line, a jagged diagonal line, or a line concave at its mid-length.

Genital capsule: plate with oblique row of macrosetae; pygofer with group of setae dorsad of outer basal angle of male plate, more or less distinct; pygofer hook arising from mesal pygofer margin, greatly variable in form.

Internal male genitalia: style with second apical extension always present; second apical extension of extremely variable form interspecifically; connective U-shaped or V-shaped with the apex turned dorsad, the aedeagal articulation usually subterminal; aedeagal form varied.

As the genus now stands, it is of inconvenient size. Probably the reason it has not been subdivided heretofore is that careful study reveals such a bewildering array of variations and intergrades as to render its separation into discontinuous groups exceedingly difficult. In the opinion of the writer, with the exception of the forms which have been relegated to *Zygina,* it is as it has been considered to date—a very large complex of closely related species.

For years, the group has been subdivided into groups of species on the basis of the form of the base of the inner apical cell of the fore wing. Beamer (1936) has pointed out that this character is subject to some variation within species, and is not infallible. Nevertheless, after considerable study, it appears likely that the groups of species based on this character are probably more natural than several other possible groupings, and more clear-cut. Some supporting characters have been found for these groups, and they are retained here, as subgenera.

The subgenera permit further subdivision, but the resulting groups leave much doubt as to whether natural relationships result.

Erythroneura subgenus *Erythroneura* Fitch

(Pl. 27, fig. 73; pl. 28, fig. 74)

See reference under generic heading.

Type of the subgenus, *Erythroneura tricincta* Fitch, by subsequent designation of Oshanin, 1912.

Hind wings: as in generic description.

Fore wings: bases of apical cells forming a transverse line which may be irregular; *base of inner apical cell transverse, seldom oblique, apex of vein Cu confluent with base of inner apical cell at or near its outer basal angle.*

Genital capsule: pygofer with a distinct group of setae just dorsad of outer basal angle of male plate; *pygofer hooks C-shaped, the dorsal arm of the hook formed by a gradual increase in sclerotization of the mesal pygofer margin, lacking a thinner, weakened basal "joint,"* occasionally with ventral arm greatly elongate or bifid (dorsal arm wanting in *tacita*).

Internal male genitalia: aedeagus variable in form, in some species with elongate preatrium bearing paired processes and with short dorsoventrally flattened shaft; in other species preatrium short or wanting and the shaft cylindrical and with or without processes; other characters as in generic description.

It is possible to further subdivide the subgenus on the basis of the shape of the aedeagus, the shape of the style, and the form of the pygofer hook. Most such groupings reveal intergrades.

In the list of species which follows, the species which has not been studied by the writer is indicated by an asterisk.

Erythroneura aclys McAtee, 1920a: 290
Erythroneura acuticephala Robinson, 1924a: 61
Erythroneura amanda McAtee, 1920a: 319
Erythroneura ancora Beamer, 1929b: 122
Erythroneura anfracta Beamer, 1929b: 123
Erythroneura aza Robinson, 1924c: 291
Erythroneura beameri Robinson, 1924a: 61
Erythroneura bidens McAtee, 1924c: 39
Erythroneura bistrata McAtee, 1920a: 305
Erythroneura caetra McAtee, 1924d: 133
Erythroneura calycula McAtee, 1920a: 308
Erythroneura cancellata McAtee, 1920a: 320
Erythroneura coloradensis (Gillette), 1892a: 16 (*Typhlocyba*)
Erythroneura comes (Say), 1825a: 343 (*Tettigonia*)
Erythroneura compta McAtee, 1920a: 318

Erythroneura corni Robinson, 1924a: 60
Erythroneura cymbium McAtee, 1920a: 310
Erythroneura delicata McAtee, 1920a: 317
Erythroneura diva McAtee, 1920a: 308
Erythroneura elegans McAtee, 1920a: 315
Erythroneura elegantula Osborn, 1928a: 289
Erythroneura festiva Beamer, 1938a: 290
Erythroneura fraxa Robinson, 1924c: 292
Erythroneura gilensis Beamer, 1929b: 123
Erythroneura infuscata (Gillette), 1898a: 764 (*Typhlocyba*)
Erythroneura integra McAtee, 1920a: 309
Erythroneura kanwakae Robinson, 1924c: 292
Erythroneura kennedyi Knull, 1945a: 109
Erythroneura nudata McAtee, 1920a: 316
*Erythroneura octonotata Walsh, 1862a: 149
Erythroneura omaska Robinson, 1924a: 62
Erythroneura ontari Robinson, 1924a: 60
Erythroneura palimpsesta McAtee, 1924e: 43
Erythroneura pontifex McAtee, 1926c: 136
Erythroneura prima Beamer, 1938a: 283
Erythroneura prosata Johnson, 1935a: 108
Erythroneura reflecta McAtee, 1924e: 43
Erythroneura rosa Robinson, 1924a: 58
Erythroneura rubra (Gillette), 1898a: 764 (*Typhlocyba*)
Erythroneura rubrella McAtee, 1920a: 316
Erythroneura tacita Beamer, 1938a: 293
Erythroneura tricincta Fitch, 1851a: 63
Erythroneura vaga Johnson, 1934a: 260
Erythroneura vagabunda Knull, 1945a: 109
Erythroneura vitifex Fitch, 1856a: 392
Erythroneura vitis (Harris), 1831a: 43 (*Tettigonia*) (*fide* Oman)
Erythroneura ziczac Walsh 1862a: 149

Erythroneura subgenus *Erasmoneura,* nov.

(Pl. 28, fig. 75)

Type of the subgenus, *Erythroneura vulnerata* Fitch.

Hind wings: As in *Zygina.*

Fore wings: as in subgenus *Erythroneura,* but *base of inner apical cell angulate,* rarely rectilinear and transverse; Cu confluent with base of inner apical cell near its midpoint.

Genital capsule: pygofer with distinct group of setae just dorsad of outer basal angle of male plate; pygofer hook simple or bifid, *with basal lightly-sclerotized jointlike portion* (except in *tecta*); other characters as in generic description.

Internal male genitalia: style with second apical extension obvious, greatly variable in form interspecifically; *aedeagal shaft extremely short,* with various processes; preatrium usually troughlike

in form; aedeagal connections to pygofer hooks very strong, even in macerated specimens.

This is the "vulnerata" group of authors. Its affinities are enigmatic. The pygofer hooks and their strong connections to the aedeagus are suggestive of subgenus *Erythridula*, whereas the reduction in the length of the shaft of the aedeagus is suggestive of the condition found in the subgenus *Eratoneura*.

A list of Western Hemisphere species follows. All of the species listed are Nearctic. All have been studied by the writer.

Erythroneura atrata Johnson, 1935a: 97
Erythroneura bicolorata Beamer, 1937a: 11
Erythroneura bipentagona Beamer, 1927a: 31
Erythroneura caerula Beamer, 1937a: 10
Erythroneura calva Beamer, 1946a: 22
Erythroneura carbonata McAtee, 1920a: 289
Erythroneura fulmina McAtee, 1920a: 274
Erythroneura mixta Beamer, 1932j: 183
Erythroneura nigerrima McAtee, 1920a: 275
Erythroneura nigra (Gillette), 1898a: 765 (*Typhlocyba*)
Erythroneura rubricata (Van Duzee), 1909a: 229 (*Typhlocyba*)
Erythroneura tecta McAtee, 1920a: 288
Erythroneura variabilis Beamer, 1929b: 126
Erythroneura vulnerata Fitch, 1851a: 61

Erythroneura subgenus *Erythridula*, nov.

(Pl. 28, fig. 76; pl. 29, fig. 77)

Type of the subgenus, *Tettigonia obliqua* Say.

Hind wings: as in *Zygina*.

Fore wings: as in subgenus *Erythroneura*, but *base of inner apical cell oblique*, and *Cu confluent with base of inner apical cell at point near middle its length.*

Genital capsule: pygofer with indistinct group of microsetae just dorsad of outer basal angle of male plate, the setae visible only under very high magnification and not conspicuously differentiated from other similar setae on pygofer; pygofer hook short and cuspidate, dorsal in origin, *not arising as uniform increase in sclerotization*, with basal lightly-sclerotized articular area appearing as joint at dorsal basal portion of hook, ventral base of hook joined to dorsal aedeagal apodeme by strong connections frequently visible even in cleared specimens.

Internal male genitalia: style with second apical extension of form greatly variable interspecifically (and occasionally intraspecifically); connective V-shaped, its apex turned dorsad, the aedeagal articulation subterminal; aedeagus variable in form, the basal portion usu-

ally broadly expanded just distad of articulation with connective, the expansion rarely wanting, shaft never thecate, usually with paired processes arising at or near its base and these separate from, completely joined to, or partially joined to shaft.

It is possible to subdivide the subgenus on the basis of the style apices (but these are extremely variable structures between species, and Beamer and Griffith (1935a) have shown one instance of intraspecific variation), or on the basis of the form of the base of the aedeagus, or on the basis of the form of the shaft. It is open to question whether such subdivisions would be natural ones, and they seem undesirable until they can be supported by more biological data than now exist.

In the following list of species, those not studied have been prefixed with an asterisk. All of the listed species are Nearctic.

*Erythroneura abolla McAtee, 1920a: 285
Erythroneura accurata Beamer, 1934b: 18
Erythroneura acicularis Beamer, 1932i: 126
*Erythroneura ador McAtee, 1918b: 361
Erythroneura aenea Beamer, 1930b: 436
Erythroneura afflicta Beamer, 1935a: 101
Erythroneura alata (?) Knull, 1946a: 45
Erythroneura albescens Beamer, 1930b: 443
Erythroneura amabilis McAtee, 1924d: 132
Erythroneura angularis Beamer, 1930b: 447
*Erythroneura anomala Knull, 1946a: 46
Erythroneura apta Beamer, 1935a: 102
Erythroneura aspera Beamer and Griffith, 1935a: 18
Erythroneura atrimucronata Beamer, 1930b: 424
Erythroneura autenae Johnson, 1935a: 73
Erythroneura bicornis Beamer, 1930b: 450
Erythroneura bitincta McAtee, 1926c: 130
Erythroneura brundusa Rob. 1924b: 155
*Erythroneura caldwelli Johnson, 1935a: 69
Erythroneura cauta Beamer, 1935a: 100
Erythroneura cavena Auten and Johnson, 1936a: 61
*Erythroneura celebrata Johnson, 1935a: 82
Erythroneura clavata (DeLong), 1916a: 105 (*Typhlocyba*)
Erythroneura coarctata Beamer, 1930b: 436
*Erythroneura complicata Johnson, 1935a: 87
*Erythroneura contrasta Auten and Johnson, 1936a: 62
Erythroneura cornipes Beamer, 1930b: 449
Erythroneura cotidiana Beamer, 1930b: 433
*Erythroneura crataegi Johnson, 1935a: 61
Erythroneura crevecoeuri (Gillette), 1898a: 767 (*Typhlocyba*)
Erythroneura cruciformis Beamer, 1930b: 443
Erythroneura cuneata Beamer, 1930b: 433
*Erythroneura decorata Auten and Johnson, 1936a: 63

Erythroneura diffisa Beamer, 1930b: 434
•Erythroneura divisa McAtee, 1924c: 37
Erythroneura dolosa Beamer and Griffith, 1935a: 19
Erythroneura dowelli Beamer, 1932b: 62
Erythroneura electa McAtee, 1920a: 282
Erythroneura eluta McAtee, 1920a: 277
Erythroneura extima Beamer, 1939a: 29
Erythroneura falcata Beamer, 1930b: 432
•Erythroneura fragilis Johnson, 1935a: 93
Erythroneura fumida (Gillette), 1898a: 758 (*Typhlocyba*)
Erythroneura funesta Beamer, 1930b: 441
Erythroneura furcillata Beamer, 1930b: 452
Erythroneura gleditsia Beamer, 1930b: 437
Erythroneura hamata Beamer, 1930b: 446
Erythroneura harpax Beamer, 1930b: 432
Erythroneura iconica McAtee, 1920a: 287
Erythroneura idonea Beamer, 1935a: 100
•Erythroneura inconspicua Johnson, 1935a: 90
Erythroneura insigna Beamer and Griffith, 1935a: 17
•Erythroneura intricata Johnson, 1935a: 86
Erythroneura jocosa Beamer, 1935a: 101
Erythroneura juglandis Knull and Auten, 1938a: 532
Erythroneura juncea Beamer, 1937a: 10
Erythroneura kanza Robinson 1924a: 58
Erythroneura latapex Beamer, 1930b: 447
Erythroneura lawsoniana Baker, 1926a: 347
•Erythroneura lusoria Van Duzee, 1924a: 234
Erythroneura magnacalx Beamer, 1930b: 451
Erythroneura malleiformis Beamer, 1930b: 449
Erythroneura mansueta Beamer, 1935a: 98
•Erythroneura minima Johnson, 1935a: 92
•Erythroneura minuta Johnson, 1935a: 93
Erythroneura modica Beamer, 1930b: 448
Erythroneura nava Beamer, 1935a: 102
Erythroneura nitida Beamer, 1935a: 103
Erythroneura noeva (Gillette), 1898a: 757 (*Typhlocyba*)
•Erythroneura nondescripta Johnson, 1935a: 92
Erythroneura obliqua (Say), 1825a: 342
Erythroneura obvia Beamer, 1930b: 439
Erythroneura ohioensis Knull, 1945a: 108
Erythroneura parvispicata Beamer, 1930b: 435
Erythroneura penelutea Beamer, 1930b: 427
Erythroneura peneoeva Beamer, 1930b: 438
Erythroneura penobliqua Beamer, 1930b: 453
Erythroneura perita Beamer, 1935a: 99
Erythroneura plena Beamer, 1930b: 442
•Erythroneura ponderosa Auten and Johnson, 1936a: 62
•Erythroneura praecisa Knull, 1946a: 46
Erythroneura quadrata Beamer, 1930b: 435
•Erythroneura repleta Johnson, 1935a: 78

Erythroneura rubens Beamer, 1930b: 439
Erythroneura rubrataeniensis Beamer, 1930b: 440
Erythroneura rubroscuta (Gillette), 1898a: 755 (*Typhlocyba*)
Erythroneura rubrotincta Johnson, 1935a: 91
Erythroneura rufostigmosa Beamer, 1930b: 429
Erythroneura sagittata Beamer, 1930b: 440
Erythroneura scissa Beamer, 1930b: 448
*Erythroneura scytha Auten and Johnson, 1936a: 61
*Erythroneura sincera Johnson, 1935a: 94
*Erythroneura sinua Johnson, 1935a: 82
Erythroneura spatulata Beamer, 1930b: 444
*Erythroneura spearca Auten and Johnson, 1936b: 818
Erythroneura stolata McAtee, 1920a: 279
*Erythroneura stulta Auten and Johnson, 1936a: 64
*Erythroneura stylata Johnson, 1935a: 78
Erythroneura tenebrosa Knull, 1946a: 48
Erythroneura tenuispica Beamer, 1930b: 444
Erythroneura torva Beamer, 1935a: 98
Erythroneura tridens Beamer, 1930b: 450
Erythroneura unicuspidis Beamer, 1930b: 452
*Erythroneura varia McAtee, 1920a: 287
Erythroneura victorialis (?) Knull, 1946a: 49
Erythroneura vinaria Beamer, 1930b: 426
Erythroneura volucris Beamer, 1930b: 445
Erythroneura xanthocephala Robinson, 1924d: 220

Erythroneura subgenus *Eratoneura*, nov.

(Pl. 29, fig. 78)

Type of the subgenus, *Erythroneura dira* Beamer.

Hind wings: as in *Zygina.*

Fore wings: base of inner apical cell varying from nearly transverse to oblique or subangulate, but most often oblique; vein Cu attaining base of inner apical cell near outer basal angle of cell, occasionally at point more mesad; otherwise as in subgenus *Erythroneura.*

Genital capsule: pygofer with distinct group of setae just dorsad of outer basal angle of male plate; pygofer hook simple or bifid, usually long and slender, *arising as gradual thickening of mesal pygofer margin,* without a basal, lightly-sclerotized jointlike portion; other features as in typical subgenus.

Internal male genitalia: style apex of various forms, but always with the second apical extension present; connective V-shaped with apex turned dorsad, the aedeagal articulation subterminal; aedeagal preatrium elongate and shaft short (except in *ballista* and *hartii*), *usually cylindrical and with rugae or minute verrucose projections;*

aedeagus usually without processes either on preatrium or on shaft.

The species included here appear more robust than those of other subgenera, and most of them possess a dark spot in the base of the inner apical cell of the fore wing. They constitute what has been called the "maculata group" of *Erythroneura*. *E. maculata* has not been selected as the type because in some respects it is not typical of the group.

The subgenus, as characterized above, permits further subdivision on the basis of the form of the aedeagus. As pointed out in the above description, the aedeagal shaft is typically warty, or at least rugose, a peculiar development which does not occur in allied groups. Moreover, this modification of the aedeagal shaft is associated usually with the lack of paired processes so frequently associated (often partially fused) with the shaft in subgenus *Erythridula*. It seems probable, from a study of the shaft in lateral view, under high magnification, in prepared slides, that these ventrolateral processes have entered into the constitution of the verrucose portion. The structure of the shaft of *Erythroneura* (*Eratoneura*) *nevadensis* (plate 29, fig. 78f) suggests that a complicating feature occurs. In this species, the two typical ventrolateral processes are expanded and flat, while arising *dorsad* of the base of the shaft is a flat hoodlike unpaired process which bears prominences typical of those which cover the shaft, or partially cover it, in most other species of the subgenus. The dorsal "hood" and the ventrolateral flat processes are fused laterad of the base of the shaft, so that the shaft, in lateral view, appears partially enclosed by one dorsal and two ventral processes, but not entirely enclosed, except for a very short basal portion. The unenclosed portion of the shaft lacks rugae or minute verrucae. Many other species, in which the shaft is verrucose or rugose, in lateral view, exhibit a gonoduct in which the outline is complicated basally in a manner suggestive of a line of fusion such as might exist if the three processes of *nevadensis* were more intimately fused. If this is true, the shaft is thecate in such species.

The relationship of the processes of *nevadensis* to the rugose shaft without processes presents a fascinating problem, the solution of which cannot be undertaken here. One group of species, here designated the *crinita* group, possesses processes *plus* a rugose or verrucose shaft. In all of the species of the *crinita* group, the position or the origin of the processes suggests that they have arisen independently and are not the homologues of the ventrolateral processes of *nevadensis*. Such species undoubtedly represent an unnatural

group and are placed together here merely for taxonomic convenience.

A second subdivision is founded on a group of species which have an aedeagal shaft which lacks ornamentation of the sort found in the more typical members of the group. It is here designated the *noncuspidis* group, and like the preceding, probably does not represent closely related species, although *marra, gillettei, maculata,* and *noncuspidis* have many features in common.

In the species lists which follow, those species not studied by the author have been prefixed with an asterisk.

Dira group

Erythroneura abjecta Beamer, 1931d: 288
Erythroneura accola McAtee, 1920a: 299
Erythroneura aculeata Beamer, 1932g: 161
Erythroneura adunca Beamer, 1932c: 46
Erythroneura aesculi Beamer, 1932c: 46
Erythroneura affinis Fitch, 1851a: 63 (*fide* Oman)
Erythroneura ardens McAtee, 1920a: 299
Erythroneura arta Beamer, 1931d: 287
Erythroneura basilaris (Say), 1825a: 344 (*Tettigonia*)
Erythroneura bella McAtee, 1920a: 300
Erythroneura bifida Beamer, 1931a: 134
Erythroneura bigemina McAtee, 1920a: 300
Erythroneura biramosa Beamer, 1941a: 18
Erythroneura bispinosa Beamer, 1931b: 241
Erythroneura brevipes Beamer, 1931a: 133
Erythroneura calamitosa Beamer, 1931b: 241
Erythroneura californica Beamer, 1932f: 143
Erythroneura campora Robinson, 1924a: 59
Erythroneura carmini Beamer, 1929b: 121
Erythroneura certa Beamer, 1932g: 159
Erythroneura clara Beamer, 1932g: 161
Erythroneura clavipes Beamer, 1931c: 269
Erythroneura concisa Beamer, 1931d: 286
Erythroneura confirmata McAtee, 1924c: 37
Erythroneura consueta Beamer, 1932d: 71
Erythroneura contracta Beamer, 1931a: 130
° Erythroneura corylorubra Knull, 1945a: 108
Erythroneura curta Beamer, 1932e: 86
Erythroneura curvata Beamer, 1931a: 132
Erythroneura delongi Knull and Auten, 1937a: 574
Erythroneura dira Beamer, 1931d: 286
° Erythroneura direpta Knull, 1949a: 125
Erythroneura dumosa Beamer, 1932a: 13
° Erythroneura era McAtee, 1920a: 299
Erythroneura externa Beamer, 1931d: 289

Erythroneura facota Beamer, 1932d: 70
Erythroneura firma Beamer, 1932a: 12
° Erythroneura flexibilis Knull, 1949a: 122
Erythroneura forfex Beamer, 1932e: 82
Erythroneura gemina McAtee, 1920a: 301
Erythroneura hyalina Knull and Auten, 1937a: 575
° Erythroneura hymac Robinson, 1924a: 60
Erythroneura immota Beamer, 1932a: 16
Erythroneura impar Beamer, 1931a: 133
Erythroneura incondita Beamer, 1932a: 16
Erythroneura inepta Beamer, 1932g: 162
Erythroneura ingrata Beamer, 1932g: 160
Erythroneura interna Beamer, 1931d: 285
Erythroneura knighti Beamer, 1932c: 87
Erythroneura lawsoni Robinson, 1924a: 59
Erythroneura lenta Beamer, 1932e: 82
Erythroneura ligata McAtee, 1920a: 301
Erythroneura linea Beamer, 1932c: 47
° Erythroneura luculenta Knull, 1949a: 124
Erythroneura lunata McAtee, 1924e: 41
Erythroneura macra Beamer, 1932a: 15
° Erythroneura malaca Knull, 1949a: 126
Erythroneura manus Beamer, 1932e: 83
Erythroneura mensa Beamer, 1931d: 287
Erythroneura minor Beamer, 1932e: 84
Erythroneura mira Beamer, 1932c: 45
Erythroneura mirifica Beamer, 1932g: 159
Erythroneura misera Beamer, 1932g: 158
Erythroneura morgani (DeLong), 1916a: 104 (*Typhlocyba*)
Erythroneura nevadensis Beamer, 1932d: 72
Erythroneura nigriventer Beamer, 1931a: 134
Erythroneura omani Beamer, 1930a: 49
Erythroneura opulenta Beamer, 1932c: 48
Erythroneura parallela McAtee, 1924c: 38
Erythroneura parva Beamer, 1932d: 70
Erythroneura parvipes Beamer, 1931b: 242
Erythroneura penesica Beamer, 1931c: 269
° Erythroneura perplexa Knull, 1944b: 123
Erythroneura propria Beamer, 1932a: 13
Erythroneura pyra McAtee, 1924d: 133
Erythroneura restricta Beamer, 1932c: 45
Erythroneura retusa Beamer, 1932c: 48
Erythroneura rotunda Beamer, 1931d: 288
Erythroneura rubranotata Beamer, 1927a: 30
Erythroneura rubraza Robinson, 1924c: 291
Erythroneura septima Beamer, 1927a: 30
° Erythroneura severini Knull, 1949a: 125
Erythroneura solita Beamer, 1932a: 14
Erythroneura spinifera Beamer, 1931b: 240

Erythroneura stephensoni Beamer, 1931a: 130
° Erythroneura stupkaorum Knull, 1945a: 104
Erythroneura tantilla Beamer, 1931d: 285
Erythroneura teres Beamer, 1931c: 268
Erythroneura torella Robinson, 1924b: 156
° Erythroneura trautmanae Knull, 1945a: 104
Erythroneura triangulata Beamer, 1931b: 240
Erythroneura trivittata Robinson, 1924a: 59
Erythroneura turgida Beamer, 1931b: 243
Erythroneura uncinata Beamer, 1931b: 242
Erythroneura ungulata Beamer, 1932d: 69
Erythroneura unica Beamer, 1932e: 83
Erythroneura univittata Robinson, 1924b: 156
Erythroneura usitata Beamer, 1932a: 14
° Erythroneura uvaldeana Knull, 1949a: 125
Erythroneura zioni Beamer, 1932d: 71

Crinita group

Erythroneura crinita Beamer, 1932e: 85
Erythroneura geronimoi Knull, 1945a: 108
Erythroneura osborni (DeLong), 1916a: 103 (*Typhlocyba*)
Erythroneura paraesculi Knull, 1945a: 106
Erythroneura sancta Beamer, 1932a: 15
Erythroneura texana Beamer, 1929b: 121

Noncuspidis group

Erythroneura andersoni Beamer, 1932a: 86
Erythroneura ballista Beamer, 1932e: 84
Erythroneura gillettei Beamer, 1931a: 128
Erythroneura hartii (Gillette), 1898a: 754 (*Typhlocyba*)
° Erythroneura hymettana Knull, 1949a: 124
Erythroneura lata Beamer, 1932e: 86
Erythroneura maculata (Gillette), 1898a: 764 (*Typhlocyba*)
Erythroneura marra Beamer, 1932g: 160
Erythroneura noncuspidis Beamer, 1931a: 129
Erythroneura penerostrata Beamer, 1932e: 85
Erythroneura rostrata Beamer, 1931c: 270
Erythroneura separata Beamer, 1932a: 12

The following species have not been studied, and could not be placed in the above groups from figures or descriptions.

° Erythroneura compressa Knull and Auten, 1937a: 573
° Erythroneura continua Knull and Auten, 1937a: 578
° Erythroneura dimidiata Knull, 1949a: 122
° Erythroneura distincta Knull and Auten, 1937a: 572
° Erythroneura pallida Knull and Auten, 1937a: 573
° Erythroneura prolixa Knull, 1949a: 126
° Erythroneura ventura Knull and Auten, 1937a: 577
° Erythroneura vittata Knull and Auten, 1937a: 577

TRIBE TYPHLOCYBINI

The leafhoppers of this group have hind wings in which the veins 1V and 2V are separate apically. The posterior branch of R is distinct and separate in some groups, combined with vein M_{1+2} in others, but this character is not believed to be a salient one (it would cleave the *Typhlocyba* complex from the *Eupteryx* complex, and these appear closely related in other characteristics). The submarginal vein is present or absent at the wing apex, and when present, it never extends beyond the apex of the outermost longitudinal vein whether the latter be the posterior branch of R or the fusion vein "R + M".

The apical venation of the fore wings appears to offer but slight basis for establishing relationships between genera.

The pygofer is quite varied, frequently possessing macrosetae on the disc, and frequently with pygofer hooks, and these are often ventral in origin. The occurrence of macrosetae in uniseriate groups on the male plates is rare.

The style typically lacks a preapical lobe or apical extension. Usually it is slender, tubular, and tapering, and usually possesses ungrouped setae along its length. Occasionally, a deltoid preapical protuberance occurs on the mesal margin of the style which superficially resembles the "heel" of the higher Erythroneurini, but which is probably unrelated to that structure, except for a possible functional relationship.

The aedeagus is quite varied in form. Frequently it is composed of a long preatrium and a short shaft. Various processes occur on it, and these are occasionally complex to the degree that they appear bizarre.

Several distinct complexes occur within the tribe, one about the genus *Eupteryx,* a complex which is characterized by the lack of the submarginal vein at the wing apex, and the frequent occurrence of complex aedeagal modifications. A second complex occurs about *Empoasca,* with a characteristic venation in the hind wing. A third complex occurs about the genus *Joruma,* and this one comprises the tribe Jorumini of McAtee. It appears no more worthy of tribal recognition than do either of the above complexes.

The writer can offer no suggestions as to the possible origin of the Typhlocybini. The group appears only distantly related to the Erythroneurini and the Dikraneurini. The Alebrini are insufficiently known, at this time, to form a conception of possible relationship to the Typhlocybini.

KEY TO GENERA AND SUBGENERA OF TYPHLOCYBINI

1. Hind wing with submarginal vein absent at wing apex (plate 28, fig. 74a) 2
   Hind wing with submarginal vein present at wing apex (plate 34, fig. 90a) 9
2. Hind wing with posterior branch of R not fused with apical portion of vein M_{1+2} (vein "R + M" does not occur) (plate 30, fig. 79a) 3
   Hind wing with posterior branch of R fused with apical portion of vein M_{1+2} (vein "R + M" present) (plate 33, fig. 88b) 6
3. Aedeagus asymmetrical, with an unpaired looped process (plate 30, fig. 79e) ..... *Eupterella*
   Aedeagus symmetrical, without a looped process 4
4. Pygofer, in lateral view, with ventrad-directed process; concave margin of style lacking setae; male plate with several macrosetae (plate 30, figs. 80c, d, e) ..... *Eupteroidea*
   Pygofer, in lateral view, with or without processes, if present, then not directed ventrad; concave margin of style with setae; male plate with or without several macrosetae 5
5. Apex of fore wing much narrower than discal portion; lower part of face, in profile, subparallel to line of dorsum; aedeagal apodeme, in caudal aspect, with opening; species robust, *Eurhadina*
   Apex of fore wing not much narrower than discal portion; lower part of face, in profile, sharply divergent from line of dorsum; aedeagal apodeme, in caudal aspect, without an opening; species slender ..... *Eupteryx*
6. Crown with median length nearly or entirely equal to median length of pronotum; ocelli present; pygofer without group of macrosetae near outer basal angle of male plate (plate 32, fig. 85c) ..... *Henribautia*
   Crown with median length much less than median length of pronotum; ocelli rarely present; pygofer with macrosetae near outer basal angle of male plate (plate 33, fig. 86c) (exception: *gillettei* group of *Typhlocyba*) 7
7. Aedeagal shaft a flattened membraneous structure occurring between a pair of arms formed by longer forcipate atrial processes (plate 33, fig. 86e) ..... *Ossiannilssonia*
   Aedeagal shaft strongly sclerotized, not so enclosed 8
8. Mesal margin of style with distinct preapical angular protruberance (plate 33, fig. 87e) ..... *Ribautiana*
   Mesal margin of style without preapical angular protruberance, or if present then scarcely developed (plate 34, fig. 89d), *Typhlocyba*
9. Hind wing with posterior branch of R not fused with apical portion of vein M_{1+2} (vein "R + M" does not occur) (plate 34, fig. 90a; plate 35, fig. 91a) 10
   Hind wing with posterior branch of R fused with apical portion of vein M_{1+2} (vein "R + M" does occur) (plate 36, fig. 94a), 13

10. Hind wing with submarginal vein confluent with apex of posterior branch of R (plate 34, fig. 90a) ..... *Eualebra*
    Hind wing with submarginal vein confluent with apex of vein M_{1+2} (plate 35, fig. 91a) 11
11. Style slender, elongate, gradually curved posterolaterad, or caliperate in dorsal aspect (plate 35, fig. 91d) ..... *Joruma* 12
    Style massive, short, strongly curved mesad at apex (plate 36, fig. 93d) ..... *Neojoruma*
12. Style, in dorsal aspect, with laterally-directed prominent spine along its length (plate 35, fig. 92d) ..... subg. *Jorumidea*
    Style, in dorsal aspect, without laterally-directed spine (seta or setae present) ..... subg. *Joruma*
13. Hind wing with fusion of posterior branch of R with veins M_{1+2} occurring much proximad of distal third of wing (plate 36, fig. 94a) ..... *Paulomanus*
    Hind wing with fusion of posterior branch of R with vein M_{1+2} in distal third of wing (plate 38, fig. 97a) 14
14. Pygofer processes arising on posterior pygofer margin; aedeagus grossly ornamented ..... *Beamerella*
    Pygofer processes arising ventrally on pygofer; aedeagus not ornamented ..... *Empoasca*

Genus *Eupterella* Delong and Ruppel

(Pl. 30, fig. 79)

Eupterella DeLong and Ruppel. Ohio Journ. Sci., vol. 50, p. 239. 1950.

Type of the genus, *Eupterella mexicana* DeLong and Ruppel, by original designation.

Hind wings: submarginal vein wanting at wing apex, fused preapically with apical portion of vein Cu_1, the portion of vein Cu_1 basad of the fusion appearing as a cross vein; posterior branch of R, vein M_{1+2}, and vein M_{3+4} separate apically; vein Cu_2 confluent with submarginal vein at a point much basad of vein m-cu; vein 1V branching from vein 2V near its base.

Fore wings: inner and outer apical cells short, broad, both failing to attain wing apex, contingent at their adjacent margins; third apical cell petiolate with its apex subtending a swollen outer portion of wing apex which usually appears somewhat falcate as a result.

Genital capsule: male plate gradually narrowed on outer margin beginning at point distad of middle its length, apex turned dorsad, with single discal macroseta on plate near base and with several poorly developed microsetae irregularly arranged; pygofer, in lateral aspect, without distinct group of isolated setae just dorsad of outer basal angle of plate, disc with numerous irregularly arranged microsetae and a row of these on posterior margin; pygofer

hooks wanting; anal hooks wanting; length of ninth sternum much less than half length of male plate.

Internal male genitalia: style, in broad aspect, smoothly curved posterolaterad towards apex, with blunt preapical angular protuberance on mesal margin, without setae; connective T-shaped or in the form of a trapezoid, the aedeagal articulation usually subterminal; *aedeagus with shaft very short and with large looped process on right side arising from atrium and greatly exceeding apex of shaft*, the apex of the process directed dorsad; preatrium wanting.

The leafhoppers placed here are fairly robust, with a triangular well-produced head. The head, including the eyes, is narrower than the pronotum, with the disc of the crown convex. The pronotum is short and slightly emarginate posteriorly. The face, in profile, is smoothly convex, with its contour divergent from the line of the dorsum. The pleural portion of the pronotum is broader than the ocellocular area. The species are variously marked with orange, black, and brown.

As far as is known, the genus is Sonoran in distribution.

In the list of species, those not studied are prefixed with an asterisk.

Eupterella acuminata DeLong and Ruppel, 1950a: 239
* Eupterella bicolor DeLong and Ruppel, 1950a: 242
Eupterella frigida DeLong and Ruppel, 1950a: 240
* Eupterella gladia DeLong and Ruppel, 1950a: 240
Eupterella huachucae (Lawson), 1930a: 135 (*Eupteryx*)
Eupterella mexicana DeLong and Ruppel, 1950a: 239

Genus *Eupteroidea*, nov.

(Pl. 30, fig. 80; pl. 31, fig. 81)

Type of the genus, *Typhlocyba stellulata* Burmeister.

Hind wings: as in genus *Eupterella*, but separation of the vannal veins occurring near their mid-length.

Fore wings: inner apical cell short, not attaining wing apex, nearly triangular; second apical cell sessile at base, very broad apically; third apical cell long-petiolate, its apex subtending an enlargement of the outer portion of the apical wing margin, the apex of the wing thus appearing falcate as in *Eupterella;* outer apical cell large, trapezoidal, not attaining wing apex, and not in contact with inner apical cell at its mesal margin.

Genital capsule: male plate, in ventral aspect, with longitudinal row of about five macrosetae near to and parallel to lateral margin over slightly more than basal half of length, lateral and mesal margins nearly parallel to just before apex where lateral margin

converges sharply and convexly towards mesal margin; in lateral aspect, plate slightly exceeding pygofer, with apex turned sharply dorsad and bearing few small setae, a very few microsetae over disc and few in row along lateral margin on apical half; pygofer, in lateral aspect with microsetae dispersed over disc and along base of posteroventral margin, without group of macrosetae near inner basal angle of male plate, posterior margin elongate, not inrolled, clothed with scalelike excrescences throughout its length and with row of setae dorsally, the scales extending down over ventrad-directed process; length of ninth sternum less than half length of plate.

Internal male genitalia: style very long, slender, tapering, gradually curved posterolaterad in basal two thirds, the apical third acicular and turned sharply laterad, *inner margin without preapical angular protuberance,* with few widely spaced alveoli near middle its length, *outer margin lacking setae and alveoli;* connective broadly T-shaped, the apex not turned dorsad, the aedeagal articulation terminal; aedeagus without preatrium, with well-developed dorsal apodeme, shaft flattened anteroposteriorly with paired preapical pointed processes extending slightly posterodorsad along shaft, each with extremely slender basal retrorse process, and extreme apex of shaft with pair of flattened flange-like processes extending posterolaterad.

In dorsal aspect, the head including the eyes is much narrower than the pronotum and somewhat produced medially, but with the apex rounded. The pronotum is much longer than the head, with lateral margins sharply divergent posteriorly, and the posterior margin scarcely emarginate. In profile, the contour of the face, below the antennae, is plane to slightly concave and divergent from the line of the dorsum. The pleural portion of the pronotum is very broad, several times the width of the ocellocular area. Female sternite VII is strongly produced and keeled medially.

Ribaut (1936b) has already called attention to the distinctness of this species. Included is only the type of the genus, a Palaearctic species with a limited Nearctic distribution.

Eupteroidea stellulata (Burmeister), 1841a: pl. 13 (*Typhlocyba*) (*fide* Oman)

Genus *Eurhadina* Haupt

(Pl. 31, fig. 82)

Eurhadina Haupt. Zool. Jahrb., Syst., vol. 58, p. 269. 1929.

Type of the genus, *Cicada pulchella* Fallén, by original designation.

Hind wings: as in genus *Eupteroidea.*

Fore wings: venation as in *Eupteroidea,* but inner apical vein somewhat variable in origin, usually occurring as continuation of vein M, but often arising more mesad along apex of cell M, and occasionally more laterad, at or near apex of cell R, the venation then approaching that of *Eupterella;* wing gradually narrowed on outer margin from expanded discal portion to conspicuously narrower smoothly rounded apex.

Genital capsule: capsule elongate, slender; male plate, in ventral aspect, with outer margin nearly straight, curved slightly posterolaterad apically, mesal margin gradually convergent towards outer margin apically, outer margin with broad, preapical triangular projection; in lateral aspect, plate exceeding apex of pygofer, with single discal macroseta on basal half, several close-set small setae at apex, and few small dispersed discal microsetae; pygofer, in lateral aspect, with posterior margin produced in rounded lobe, with row of small setae along posterodorsal margin and numerous microsetae on disc, without distinct group of setae just dorsad of outer basal angle of male plate; posterior margin not inrolled and differentially sclerotized; length of ninth sternum more than half length of male plate.

Internal male genitalia: style elongate, slender, *curved gradually dorsad* towards apex, *without preapical angular protuberance,* extreme apex slightly curved laterad, with row of widely spaced setae along dorsal margin; connective Y-shaped and with Y-shaped thickening, not curved dorsad apically, the aedeagal articulation terminal; aedeagus strongly recurved, preatrium wanting; shaft with two pairs of branched apical processes but none along length; dorsal apodeme well developed, in *caudal aspect with an opening near its summit.*

The leafhoppers included here appear robust, in dorsal aspect, as a result of the broadened discal portion of the fore wings. The head, including the eyes, is narrower than the pronotum, and is well produced medially, in dorsal aspect with the anterior margin broadly rounded. The pronotum is much longer than the head, with lateral margins divergent posteriorly and with the posterior margin scarcely emarginate. In profile, the line of the dorsum is gradually declivent anterior to the disc of the pronotum. The face is angulate, the contour of its lower portion nearly parallel to the line of the dorsum. The pleural portion of the pronotum is very much broader than the ocellocular area.

One species, the first of those listed below, has been taken in Massachusetts, but males from this locality appear to be rare in North American collections. A single male with genitalia corre-

sponding to Ribaut's figures of *concinna* had fore wings with a venation much similar to that of *Eupterella.* The second species listed below is known from a single specimen taken in Long Island. The specimen is in the United States National Museum collection.

Eurhadina concinna (Germar), 1831a: 12 (*Tettigonia*) (*fide* Oman)
Eurhadina Loewi (Then), 1886a: 54 (*Eupteryx*)

Genus *Eupteryx* Curtis

(Pl. 31, fig. 83; pl. 32, fig. 84)

Eupteryx Curtis. Ent. Mag., vol. 1, p. 192. 1833.

Type of the genus, *Cicada picta* Fabricius, 1803, which is a synonym of *Cicada atropunctata* Goeze, 1778 (original designation).

Hind wings: venation as in genus *Eupteroidea.*

Fore wings: inner and outer apical cells not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate; inner apical vein arising from cell R or M.

Genital capsule: male plate, in ventral aspect, broad basally, gradually narrowed on outer margin to rounded apex, chaetotaxy various, a single macroseta near inner basal angle of male plate or more distad on disc, a single oblique row of macrosetae, or an oblique double row; in lateral aspect, plate often with poorly-developed submarginal row of microsetae parallel to lateral margin; pygofer, in lateral aspect, well produced, *with discoid cluster of macrosetae just dorsad of outer basal angle of male plate* and with numerous microsetae irregularly scattered over posterior half of disc, *posterior margin rolled mesad and sclerotized heavily,* the inrolled margin often modified to form pygofer hook extending above upper pygofer margin, or not extending so far but sclerotized so as to appear as internal pygofer process; length of ninth sternum nearly half length of male plate.

Internal male genitalia: style elongate, curved smoothly laterad through most of its length, with preapical deltoid protuberance on mesal margin, with small setae extending laterad along outer margin and few alveoli along inner margin, both anterior to deltoid protuberance; connective much shorter than style, Y-shaped or triangular, its apex usually turned dorsad and the aedeagal articulation subterminal; *aedeagus typically with pair of apical processes, lacking atrial processes;* preatrium short or wanting.

The head, in dorsal aspect, is distinctly produced medially, and varies from nearly deltoid with the apex rounded, to smoothly curved on the anterior margin. The head is usually narrower than the pronotum. In lateral aspect, the contour of the face is smoothly

convex. The pleural portion of the pronotum is wider than the ocellocular area. The pronotum is longer than the head, with lateral margins divergent posteriorly and with posterior margin rectilinear or very shallowly emarginate.

As here restricted, the genus includes the *aurata, artemesiae, urticae, melissae,* and *vittata* groups of Ribaut, in addition to the North American *furcata* group which appears distinct from the Palaearctic species studied. The venation of the fore wing of the *melissae* group differs from that of the *vittata* group in that in the former the inner apical vein arises from cell R instead of from cell M. In the *furcata* group, the pygofer hook extends beyond the pygofer margin.

The distribution of the genus is problematical. It is at least Holarctic. The author does not know whether species from Queensland described by Kirkaldy, from India by Distant, and from Japan by Matsumura, are congeneric with this or with allied genera treated here.

In the list of species below, *vanduzei* could not be placed, because no males were found among the rather large number of specimens examined. Perhaps males of this species do not occur. No males of *juvenis* were available for study.

Vittata group

Eupteryx artemesiae (Kirschbaum), 1868b: 190 (*Typhlocyba*) (*fide* Oman)

Furcata group

Eupteryx clavalis McAtee, 1919c: 185
Eupteryx flavoscuta Gillette, 1898a: 749
Eupteryx furcata (Beamer), 1943b: 133 (*Typhlocyba*), new combination
Eupteryx nigra Osborn, 1905c: 543

Melissae group

Eupteryx melissae Curtis, 1837d: 640 (*fide* Oman)

Species incertae sedis

Eupteryx juvenis McAtee, 1919c: 186
Eupteryx vanduzei Gillette, 1898a: 748

Genus *Henribautia* Young and Christian, nov.

(Pl. 32, fig. 85)

Type of the genus, *Typhlocyba nigricephala* Beamer.

Hind wings: vein 1V branching from vein 2V near its midlength; submarginal vein absent at wing apex; posterior branch of R fused with apical portion of vein M_{1+2}; otherwise as in genus *Eupterella.*

Fore wings: inner and outer apical cells short, not attaining wing apex; second apical cells much broader at apex than at base; third apical cell petiolate; wing apex somewhat oblique.

Genital capsule: male plate, in ventral aspect, broadened on basal half, abruptly narrowed near middle of length to narrow upturned apex; in lateral aspect with single macroseta near outer basal angle of male plate, and few small setae on apical half; pygofer, in lateral aspect, with large group of microsetae on ventral half of disc, *completely without macrosetae*, with posteroventral margin slightly expanded, without pygofer hooks, posterior margin not inrolled nor differentially sclerotized, posterodorsal margin with or without row of small setae; anal hooks wanting.

Internal male genitalia: style narrow, gradually tapered and curved laterad on apical half, with preapical triangular protuberance in inner margin, with one or few setae on outer and several alveoli on inner margin near middle of length; connective Y-shaped, the stem broad, with median dorsal keel extending distad over aedeagal articulating surface, the aedeagal articulation thus subterminal; aedeagus without preatrium, dorsal apodeme simple, well developed, shaft slender, elongate, with paired apical processes.

The head is well produced medially, and conical, the median length of the crown greatly exceeding the length next the eye. The head is nearly, or quite, as long as the pronotum. The pronotum is broader than the head, the lateral margins divergent posteriorly, the posterior margin scarcely emarginate. In lateral aspect, the crown is sharply rounded to the slightly convex face, the contour of which is divergent from the line of the dorsum. The pleural portion of the pronotum is much broader than the ocellocular area. Ocelli are present, situated on the margin between crown and face, and not near the compound eyes.

This genus is named in honor of Dr. Henri Ribaut, whose excellent work on the French fauna has served as a stimulus to other workers in the field.

Three species have been examined which belong to this genus, one species of which is undescribed. The known distribution is Sonoran.

Henribautia hubbardi (McAtee), 1924c: 35 (*Erythroneura*), new combination

Henribautia nigricephala (Beamer), 1943b: 132 (*Typhlocyba*), new combination

Genus *Ossiannilssonia* Young and Christian, nov.

(Pl. 33, fig. 86)

Type of the genus, *Typhlocyba berenice* McAtee.

Hind wings: as in genus *Henribautia.*

Fore wings: as in genus *Henribautia,* but with the apices smoothly rounded.

Genital capsule: male plate, in ventral aspect, gradually narrowed on outer margin towards apex, occasionally with small lobe on lateral margin before apex, never with oblique row of macrosetae, and *without a single macroseta near outer basal angle of male plate* (except in *sexnotata*) with microsetae irregularly arranged; pygofer, in lateral aspect, *with posterior margin distinct, not rounded to posteroventral margin,* rectilinear in form; pygofer wall frequently with sclerotized bars occurring within the limits of the pygofer proper, or prolonged posterodorsally or posteriorly as short pygofer hooks; a group of macrosetae usually present on pygofer just dorsad of outer basal angle of male plate, a row of small setae located posterodorsally, and a row of microsetae on disc extending dorsocaudad from the group of macrosetae; anal hooks wanting.

Internal male genitalia: style elongate, slender, gradually curved laterad or dorsolaterad apically, *without triangular preapical projection on inner margin* (present on outer margin in *flavomarginata*) with elongate slender setae on outer margin and almost always with few alveoli on inner margin; connective triangular or Y-shaped; aedeagus with preatrium distinct, aedeagal apodeme short, well developed or not, *shaft occurring as flattened membranous structure included between basal portions of a pair of forcipate atrial processes* which are branched or not.

In dorsal aspect, the head, including the eyes, is narrower than the pronotum, and only slightly produced medially to the rounded anterior margin, the median length of the crown not greatly exceeding the length next the eye. The pronotum is short, but much longer than the head, with lateral margins greatly divergent posteriorly, and with the posterior margin shallowly concave. In lateral aspect, the face is strongly convex to slightly below the antennal insertions, then slightly convex to the tip of the clypellus. The width of the pleural portion of the pronotum greatly exceeds the width of the ocellocular area. Ocelli are present or absent, when present, situated on the rounded margin between crown and face, and nearer the eyes than to each other. The species are usually pale in color, with dark markings before the bases of the apical cells, but with dark markings occasionally more extensive. The color markings are red in a few species.

This genus is related to the *cruenta* group of *Typhlocyba* of Ribaut (1936). It is also closely related to the rosae group of *Typhlocyba.* It is named in honor of Dr. Frej Ossiannilsson, of

Uppsala, Sweden, who has contributed much to our knowledge of the Homoptera.

A list of included species follows. The genitalia of the type of *clymene* were partly missing, and no conclusions could be drawn from their examination, but the species is placed here on the basis of McAtee's figures. The type of *eurydice* was in slightly better condition, but the membranous portion of the shaft of the aedeagus could not be seen. The type was the only male available for this study. The species prefixed with a single asterisk have not been studied. No male of *duplicata* was available at the time of this study.

Ossiannilssonia antigone (McAtee), 1926a: 35 (*Typhlocyba*), new combination
Ossiannilssonia appendiculata (Malloch), 1920a: 95 (*Typhlocyba*), new combination.
Ossiannilssonia berenice (McAtee), 1926a: 38 (*Typhlocyba*), new combination
Ossiannilssonia clymene (McAtee), 1926a: 36 (*Typhlocyba*), new combination
Ossiannilssonia danae (McAtee), 1926a: 37 (*Typhlocyba*), new combination
Ossiannilssonia duplicata (McAtee), 1926a: 16 (*Typhlocyba*), new combination
Ossiannilssonia eurydice (McAtee), 1926a: 37 (*Typhlocyba*), new combination
Ossiannilssonia flavomarginata (Gillette and Baker), 1895a: 111 (*Typhlocyba*), new combination
Ossiannilssonia hermione (McAtee), 1926a: 38 (*Typhlocyba*), new combination.
* Ossiannilssonia hinei (Knull), 1944a: 272 (*Typhlocyba*), new combination
Ossiannilssonia nicarete (McAtee), 1926a: 36 (*Typhlocyba*), new combination
Ossiannilssonia phryne (McAtee), 1926a: 34 (*Typhlocyba*), new combination
Ossiannilssonia quadrata (DeLong and Johnson), 1936a: 102 (*Typhlocyba*), new combination
* Ossiannilssonia serrula (Ross and DeLong), 1949a: 118 (*Typhlocyba*), new combination
Ossiannilssonia sexnotata (Van Duzee), 1914a: 57 (*Empoa*), new combination
Ossiannilssonia troza (Ross and DeLong), 1949a: 117 (*Typhlocyba*), new combination
Ossiannilssonia tunicarubra (Gillette), 1898a: 752 (*Typhlocyba*), new combination

Genus *Ribautiana* Zakhvatkin[1]

(Pl. 33, fig. 87)

Ribautiana Zakhvatkin. Rev. Ent. URSS, 1945 nos. 3-4, p. 112. 1947.

Type of the genus, *Cicada ulmi* Linnaeus, by original designation.

Hind wings: as in genus *Henribautia.*

Fore wings: as in genus *Henribautia,* but with the apices smoothly rounded.

Genital capsule: male plate, in ventral aspect, abruptly narrowed near middle its length, to narrow upturned divergent apex, with

1. See footnote 2, title page.

single macrosetae near outer basal angle, and two smaller setae near lateral margin near middle of plate; in lateral aspect with a number of scattered microsetae, some of them tending to form a submarginal row along lateral margin; pygofer, in lateral aspect, *with group of macrosetae just dorsad of outer basal angle of male plate,* and with numerous microsetae in region caudad and dorsad of these, posterior margin scarcely inrolled, not differentially sclerotized, posterior margin not well differentiated, merging with ventral margin; pygofer hooks wanting; anal hooks wanting.

Internal male genitalia: style elongate, slender, gradually tapering and curved laterad or dorsad towards apex, the *inner margin with preapical triangular protuberance;* outer margin with few long setae and inner margin with several alveoli; connective Y-shaped or triangular, the aedeagal articulation terminal or subterminal; aedeagus without preatrium, aedeagal apodeme well developed, simple, *atrial processes or basal shaft processes present,* and one or more pairs of processes more distad on the elongate shaft.

The head, in dorsal aspect, is narrower than the pronotum, and scarcely produced, its median length not greatly exceeding the length next the eye. The anterior margin of the crown is smoothly rounded. The pronotum is short, with lateral margins greatly divergent posteriorly, and with the posterior margin shallowly emarginate. In profile, the contour of the face is convex and divergent from the line of the dorsum. The width of the pleural portion of the pronotum greatly exceeds the width of the ocellocular area. Ocelli are absent. All of the species have dark markings at the apices of the veins which form the distal margins of the inner and outer apical cells of the fore wings.

The genus has a Holarctic distribution. The following Nearctic species are included. Those species prefixed with an asterisk had not been studied at the time of writing. No Nearctic specimens of *tenerrima* have been seen.

Ribautiana foliosa (Knull), 1945a: 104 (*Typhlocyba*), new combination
Ribautiana luculla (Medler), 1942a: 139 (*Typhlocyba*), new combination
* Ribautiana piscator (McAtee), 1926a: 7 (*Typhlocyba*), new combination
* Ribautiana sciotoensis (Knull), 1945a: 103 (*Typhlocyba*), new combination
Ribautiana surda (DeLong and Johnson), 1936a: 101 (*Typhlocyba*), new combination
Ribautiana tenerrima (Herrich-Schaeffer), 1834b: No. 10a (*fide* Oman)
Ribautiana ulmi (Linnaeus), 1758a: 439 (*Cicada*)
Ribautiana unca (McAtee), 1926a: 8 (*Typhlocyba*), new combination

Genus *Typhlocyba* Germar[1]

(Pl. 33, fig. 88; pl. 34, fig. 89)

Typhlocyba Germar. *In* Silbermann's Rev. Ent. vol. 1, p. 180. 1833.
Empoa Fitch. Ann. Rep. New York St. Cab. Nat. Hist., p. 63. 1851 (type. *Empoa querci* Fitch, 1851, by subsequent designation of Van Duzee (Check List Hemip., p. 77. 1916)).
Anomia Fieber. Verh. zool.-bot. Ges. Wien, vol. 16, p. 509. 1866 (type, *Cicada quercus* Fabricius, 1794, by subsequent designation of Evans (Trans. Roy. Ent. Soc. London, vol. 98, p. 200. 1947)).
Edwardsiana Zakhvatkin. Rev. Russe d'Ent., vol. 23, p. 262. 1929 (type, *Cicada rosae* Linnaeus, by original designation).

Type of the genus, *Cicada quercus* Fabricius, by subsequent designation of Woodworth, 1889.

Hind wings: as in genus *Henribautia.*

Fore wings: as in genus *Henribautia,* but with apices smoothly rounded.

Genital capsule: male plate gradually curved dorsad apically, *with single macroseta near outer basal angle,* and submarginal row of microsetae parallel to lateral margin near middle of its length, occasionally extending over apical half of length, with few other irregularly arranged microsetae; pygofer, in lateral aspect, of various forms, with or without sclerotized barlike thickenings which when present may or may not be extended as posterior or posterodorsal pygofer processes, with posteroventral margin occasionally inrolled, often with group of macrosetae just dorsad of outer basal angle of male plate, almost always with group of small submarginal setae along posterodorsal margin and with numerous microsetae arranged over disc.

Internal male genitalia: style elongate, slender, usually either smoothly curved laterad or dorsad apically, or with apex abruptly curved laterad and appearing setiform in dorsal aspect (style sinuous in *aureotecta* and *rubriocellata*), with mesal preapical protuberance poorly developed or absent in broad aspect (which may be dorsal or caudal); style with setae in various arrangements; connective massive, the aedeagal articulation subterminal; aedeagus with preatrium well developed or not, apodeme usually well-developed, shaft varied; with paired ventral processes arising from atrium or base of shaft, or with two pairs of apical processes (one pair in *tortosa, niobe* and *lancifer*), and occasionally with dorsal processes along length of shaft.

The species, for the most part, are slender and delicate in appearance. In dorsal aspect, the head is narrower than the pronotum, and longer medially than next the eye. The anterior

1. See footnote 2, title page.

margin of the crown is broadly rounded. The pronotum is short and broad, with the lateral margins strongly divergent posteriorly and the posterior margin smoothly, shallowly concave. In profile, the contour of the face is smoothly convex (except in *querci* and some related species, where the clypellus is often conspicuously gibbous), and divergent from the line of the dorsuum. The pleural portion of the pronotum is much broader than the ocellocular area. The color is usually pale white or yellow, occasionally with darker markings.

In genital structure, the group is heterogeneous, but although groups of species occur with similar genital structure, other species usually occur with an intermediate pattern, so that the array appears too nearly continuous for further subdivision, even though the magnitude of difference between some of the groups is of the same order as that used, in this treatment, as a basis for segregating species groups, as genera, from this one.

In the list of species which follows, those species not studied at the time of writing are prefixed with an asterisk. There has been some confusion concerning the status of *querci* Fitch. It seems probable that Fitch had a mixed population in mind at the time he wrote the original description, which might have led him to append to the original description, the phrase, "sometimes excessively numerous" (on oaks). We know, now, that several species occur on oak. Gillette (1898a) retained the name *querci* Fitch and referred to *bifasciata* Gillette and Baker as a variety of Fitch's species. McAtee (1926a) listed *bifasciata* Gillette and Baker in synonymy under *gillettei* Van Duzee, and further indicated in his discussion of the nomenclature of the species, that he considered *gillettei* Van Duzee, in a sense, as a substitute name for *querci* Fitch. The writers are of the opinion, then, that the identity of *querci* Fitch already has been fixed, and that since McAtee's rejection of Fitch's name was invalid, then one of the varieties of McAtee's *gillettei* must be chosen as the typical variety of *querci* Fitch. Variety *fitchii* McAtee has been chosen because it is appropriate from the standpoint of fitting the original description, of occurring on oak (although not known to be "excessively numerous"), and of occurring in New York.

Typhlocyba andromache McAtee, 1926a: 32
Typhlocyba ariadne McAtee, 1926a: 14
° Typhlocyba ariste McAtee, 1926a: 13
Typhlocyba arsinoe McAtee, 1926a: 31
° Typhlocyba athene McAtee, 1926a: 31
Typhlocyba aureotecta (Sanders and DeLong), 1917a: 93 (*Empoa*)

Typhlocyba cassiopeia Knull, 1944a: 269
Typhlocyba commissuralis Stål, 1858e: 196 (*fide* Oman)
Typhlocyba crassa DeLong and Johnson, 1936a: 102
Typhlocyba cymba McAtee, 1918b: 360
° Typhlocyba dorsti Ossiannilsson, 1936a: 10
° Typhlocyba enascora DeLong and Johnson, 1936a: 103
Typhlocpba euphrante McAtee, 1926a: 12
Typhlocyba expanda DeLong and Johnson, 1936a: 104
Typhlocyba froggatti Baker, 1925b: 537
Typhlocyba hockingensis Knull, 1944a: 270
Typhlocyba lancifer McAtee, 1926a: 19
Typhlocyba melite McAtee, 1926a: 32
Typhlocyba modesta Gibson, 1917a: 184
° Typhlocyba oneka Knull, 1944a: 270
Typhlocyba pomaria McAtee, 1926a: 29
Typhlocyba prunicola Edwards, 1914a: 168
Typhlocyba putmani Knull 1944a: 269
Typhlocyba querci (Fitch), 1851a: 63 (*Empoa*)
var. querci (Fitch), 1851a: 63 (*Empoa*)
gillettei var. *fitchii* McAtee, 1926a: 25, new synonymy
var. sincera McAtee, 1926a: 25
var. apicata McAtee, 1926a: 25
var. saffrana McAtee, 1926a: 26
var. russeola McAtee, 1926a: 26
var. casta McAtee, 1926a: 26
var. gillettei Van Duzee, 1916a: 77
var. volans McAtee, 1926a: 28
var. scripta McAtee, 1926a: 28
var. venusta McAtee, 1926a: 29
var. sellata McAtee, 1926a: 29
var. vestita McAtee, 1926a: 29
Typhlocyba quercus (Fabricius), 1794a: 47 (*Cicada*)
Typhlocyba rosae (Linnaeus), 1758a: 439
Typhlocyba rubriocellata Malloch, 1920b: 48
Typhlocyba shawneeana Knull, 1944a: 270
° Typhlocyba sollisa Ross and DeLong, 1949a: 116
Typhlocyba spinosa Beamer, 1943b: 131
Typhlocyba surcula DeLong and Johnson, 1936a: 103
Typhlocyba tortosa Ross and DeLong, 1949a: 115

Genus *Eualebra* Baker

(Pl. 34, fig. 90)

Eualebra Baker. Psyche vol. 8, p. 402. 1899.

Type of the genus, *Eualebra smithii* Baker, by original designation.

Hind wings: vein 1V branching from vein 2V basad of its midpoint; submarginal vein present, extending around wing apex and confluent with apex of posterior branch of R; posterior branch of

vein R not fused with apical portion of vein M_{1+2}; apical portion of vein Cu_1 not fused with apical portion of vein M_{3+4} (vein Cu_1 appears branched apically); vein Cu_2 confluent with submarginal vein at point nearly opposite vein m-cu.

Fore wings: wing broad, short; inner and outer apical cells not attaining wing apex; all apical cells sessile; second and third apical cells much broader at apex than at base; preapical (greatest) widths of cells R and M subequal.

Genital capsule: plates short, but greatly exceeding short pygofer; plate, in ventral aspect, broad, nearly parallel-margined to apex which is very bluntly angulate in macerated specimens, with numerous macrosetae on disc laterally; pygofer, in lateral aspect, without setae; posterior margin smoothly convex; pygofer arising internally on pygofer wall, extending mesad short distance, then curved sharply anteroventrad then gradually dorsad and mesad, the apical half bisinuate.

Internal male genitalia: style slender, short, slightly curved mesad, gradually tapered to acute apex, with few alveoli on apical half, and one or several minute setae; connective U-shaped, each arm giving off a dorsal projection; aedeagus short, simple, laterally compressed; preatrium and dorsal apodeme short but distinct.

In form, these insects are broad and flat. The head is well produced medially, the median length nearly equal to the width between the eyes, and only slightly less than the median length of the pronotum. The width of the head, including the eyes, is less than the width of the pronotum. The margin of the crown, in dorsal aspect, extends straight anteriorly a short distance before each eye, the apex broadly paraboloid. The pronotum is short and broad, the lateral margins divergent posteriorly, the posterior margin rectilinear. In lateral aspect, the face and crown are depressed, the contour of the face nearly parallel to the line of the dorsum. The pleural portion of the pronotum is much broader than the ocellocular area.

The species are white or yellowish marked with dark, red, or orange. The veins at the apex of the fore wings are pink.

Eualebra reticulata (Osborn), 1928a: 279 [*Dikraneura* (*Hyloidea*)], new combination

Eualebra smithii Baker, 1899b: 402

The holotype of *Eualebra notata* Baker, a female, from the Pomona College collection, has been examined and provided with a type label. The wing aspices are damaged. The specimen has fused vannal veins, and probably should be placed in the Dikraneurini.

Genus *Joruma* McAtee

Joruma McAtee. Florida Ent., vol. 8, p. 34. 1924.
Joruma (*Jorumella*) McAtee, Proc. Zool. Soc. London, 1934, p. 113 (type, *Joruma ascripta* McAtee, by original designation).

Type of the genus, *Joruma pisca* McAtee, by original designation.

Hind wings: vannal veins separate apically; submarginal vein extending around wing apex to apex of vein M_{1+2} with which it is confluent; posterior branch of R occurring as short spur, not confluent with apical portion of vein M_{1+2}; vein Cu_1 confluent with apical portion of vein M_{3+4} (vein Cu_1 appears unbranched apically); vein Cu_2 confluent with submarginal vein in basal half of wing.

Fore wings: inner apical cell broad and angulate at base, the pointed apex not attaining the wing apex; second and third apical cells sessile, narrower at base than at apex and gradually widened apically, the combined apices subtending the wing apex; second apical cell slightly longer than third; outer apical cell nearly always open basally.

Genital capsule: male plate elongate, exceeding apex of pygofer, with uniseriate macrosetae present; pygofer nearly always without setae arranged in groups; pygofer hooks nearly always wanting; anal hooks present.

Internal male genitalia: style elongate, slender; connective triangular or Y-shaped; aedeagus with or without processes, preatrium present or absent.

Joruma subgenus *Joruma* McAtee

(Pl. 35, fig. 91)

Joruma McAtee. Florida Ent., vol. 8, p. 34. 1924.
Joruma (*Jorumella*) McAtee. Proc. Zool. Soc. London 1934, p. 113 (type, *Joruma ascripta* McAtee, by original designation).

Type of the subgenus, *Joruma pisca* McAtee, by original designation.

Wings: as in generic description.

Genital capsule: male plate, in lateral aspect usually very long and slender, greatly exceeding apex of pygofer, with uniseriate macrosetae extending nearly throughout length of plate or occurring in much shorter row, microsetae usually present and variously arranged; pygofer with posterodorsal margin somewhat produced, without distinct posterior margin, this merging with ventral margin; pygofer usually without groups of setae on disc (exceptions: *proxima* and *ascripta*) usually with very few microsetae irregular in position; pygofer hooks wanting except in a single undescribed species; anal hooks well developed and variable in form between

species, occasionally very long, extending ventrad then mesad, their apices crossing.

Internal male genitalia: style, in dorsal aspect, slender, expanded slightly on outer margin from opening of lumen to portion just basad of apex, apex slender, gradually tapered, with few minute denticles on dorsal face, outer margin with one or two setae just before narrowed apical portion, apex greatly exceeding apex of connective; connective a solid plate, broadly triangular, or Y-shaped, with apical notch bearing base of aedeagus; aedeagus usually with preatrium elongate (exception: *proxima*), with various processes on atrium or shaft, dorsal apodeme not well differentiated.

The head is well produced. In dorsal aspect, the median length of the crown usually exceeds the width between the eyes, and is nearly equal to the median length of the pronotum. The pronotum is short, its width greatly exceeding its length, with lateral margins divergent posteriorly and posterior margin shallowly concave. In lateral aspect, the contour of the face is convex, and strongly divergent from the line of the dorsum. The pleural portion of the pronotum is narrow, but broader than the ocellocular area. The crown in lateral aspect is often slightly concave. Ocelli are present.

Although the venation of the hind wings of *ascripta* and *neascripta* is distinct from the more typical members of the genus, little can be found to support the separation of these as a separate genus.

The known distribution is primarily Neotropical, with two species known from the Nearctic region.

In the list of species which follows, those species of which only female specimens have been seen by the writer are prefixed with a single asterisk, while those which have not been seen at all are prefixed with a double asterisk.

Joruma albifrons McAtee, 1926b: 166
Joruma ascripta McAtee, 1926b: 167
**Joruma atratula McAtee, 1926b: 170
*Joruma aurata McAtee, 1926b: 168
*Joruma cingulata McAtee, 1926b: 167
*Joruma coccinea McAtee, 1926b: 166
*Joruma ebria McAtee, 1926b: 169
Joruma feminea McAtee, 1926b: 169
**Joruma fumosa Osborn, 1928a: 283
Joruma fuscoclavata Osborn, 1928a: 281
Joruma neascripta Oman, 1937d: 568
*Joruma nigricans Osborn, 1928a: 281
**Joruma peltata McAtee, 1926b: 168
Joruma pisca McAtee, 1924c: 34
Joruma proxima McAtee, 1926b: 168
**Joruma semenula McAtee, 1926b: 169
**Joruma subaurata McAtee, 1926b: 168

Joruma subgenus *Jorumidia*, nov.

(Pl. 35, fig. 92)

Type of the subgenus, *Joruma curvata* Osborn.

Wings: as in generic description.

Genital capsule: male plate, in ventral aspect, broad at base, narrowed at basal third on outer margin, then slender to apex, with row of few macrosetae in region of narrowing of plate; plate, in lateral aspect, considerably exceeding apex of pygofer and usually with few microsetae in irregular row along later margin on posterior half, and few longer microsetae at apex; pygofer with few or without microsetae, without macrosetae; pygofer hooks wanting; anal hooks well developed.

Internal male genitalia: style slender, gradually tapered to truncate apex, in dorsal aspect with dorsal surface provided with transverse rugae; *lateral margin with conspicuous spur directed laterad;* connective Y-shaped, the apex with a median dorsal keel overhanging aedeagal articulation; aedeagus with or without preatrium and without processes, dorsal apodeme well developed, simple, shaft gradually curved dorsad.

The species are similar to typical *Joruma* in appearance.

The known distribution is Neotropical and Sonoran.

Joruma curvata Osborn, 1928a: 284
Joruma minuta Lawson, 1930a: 136

Genus *Neojoruma*, nov.

(Pl. 36, fig. 93)

Type of the genus, *Joruma adusta* McAtee.

Wings: as in genus *Joruma*, but with base of outer apical cell of fore wing distinct.

Genital capsule: male plate, in lateral aspect, very long, very greatly exceeding apex of pygofer, its lateral margin sinuous throughout its length, with discal row of macrosetae over middle third, a dense tuft of very fine long setae extending dorsad near base and numerous irregularly arranged microsetae on disc near base and near apex of plate; pygofer with posterodorsal margin produced, posterior margin short, disc without setae, with single small seta near posteroventral pygofer margin in its upper half; pygofer hooks wanting; anal processes broad, flat.

Internal male genitalia: style short, thick, its apex massive and extending mesad at right angles to long axis, its extreme tip obliquely truncate, somewhat concave; connective Y-shaped, its apex greatly

exceeding apices of styles; aedeagus enormous, preatrium distinct, *atrial rim heavily sclerotized and giving off a pair of posteriorly directed forcipate processes dorsally and a decurved short apodeme on each side,* shaft laterally compressed, with apical median ventral keel and an apical dorsal process shallowly bifurcate at tip.

The head, in dorsal aspect, is short and broadly rounded anteriorly, with anterior and posterior margins subparallel. The median length of the crown is approximately equal to the length next the eye. The width of the head, including the eyes, is much less than the width of the pronotum. The pronotum is short and broad with lateral margins scarcely developed, and with posterior margin straight, not emarginate. In lateral aspect, the contour of the face is convex, and strongly divergent from the line of the dorsum. The pleural portion of the pronotum is narrow, scarcely wider than the ocellocular area.

Only the type of the genus, a Brazilian species, is known.

Neojoruma adusta (McAtee), 1924c: 35 (*Joruma*), new combination

Genus *Paulomanus,* nov.

(Pl. 36, fig. 94; pl. 37, fig. 95)

Type of the genus, *Paulomanus cecropiae*, n. sp.

Hind wings: vein 1V separating from vein 2V near its base; submarginal vein extending around wing apex and confluent with apex of vein "R + M"; apical portion of Cu_1 fused with apical portion of vein M_{3+4} (vein Cu_1 appears unbranched apically); free portion of vein M_{3+4} occurring near midlength of wing; Cu_2 confluent with submarginal vein in basal half of wing, a pronounced sinus occurring at the point of confluence; wing apex truncate.

Fore wings: inner and outer apical cells elongate, neither attaining wing apex; inner and third apical cells subequal in length; outer apical cell open basally; apical width of cell M greatly exceeding apical width of cell R; cell M extending more distad than cell R.

Genital capsule: male plate expanded dorsad near middle of its length, with smaller lateral lobe beneath expanded portion, the smaller lobe close-set with microsetae, a small group of microsetae ventrad of lateral lobe and another similar group on lateral margin near base and a few small subapical setae on disc; pygofer with distinct posterodorsal lobe, lacking setae except few submarginal microsetae near base of anal tube; pygofer hooks arising from ventral margin of pygofer, extending posterodorsad, slender, cylindrical, tapering to acute tips; anal hooks wanting.

Internal male genitalia: style without preapical lobe or apical extension, apex of outer margin extended laterad, in broad aspect, inner margin forming mesal blunt protuberance, then extended laterad forming a distinct sinuous posterior margin which converges gradually to the outer margin; outer margin with few ciliate preapical hairs; connective Y-shaped, the apex turned dorsad, the aedeagal articulation subterminal; aedeagus with preatrium short, distinct, dorsal apodeme large, with anterior and posterior lobes, flattened laterally; shaft dorsoventrally flattened, keeled laterally, with four retrorse dorsally-arising processes near apex, these extending basad about one third length of shaft, apex of shaft truncate.

This genus is named in honor of Dr. Paul W. Oman, of the Division of Insect Identification of the United States Department of Agriculture, who was partly responsible for the choice of the subject of this research, and who has co-operated during its progress through numerous helpful suggestions.

Paulomanus cecropiae, n. sp.

Form. Head not greatly produced before eyes, width between eyes less than one-third greater than median length of crown; disc of crown flattened to concave in lateral aspect; width of head, including eyes, exceeding greatest width of pronotum; line of crown forming nearly a right angle with line of face in profile; face broadly convex. Pronotum about one third longer than median length of crown, subequal in length to scutellum; lateral margins slightly convex and convergent posteriorly; posterior margin nearly transverse. Wings, genitalia, and genital capsule as in generic description.

Color. Male. Ground color of crown ivory, with an arcuate transverse burnished orange stripe between the eyes; pronotum sooty black with median longitudinal area of variable width burnished orange to yellow; fore wings opaquely mottled with burnished orange except sooty black costal plaque, a darker spot just posterior to plaque and pair of paler spots in clavus, one near anal angle of wing and one at level of midpoint of clavus, apical third abruptly hyaline, the veins and margin pale yellow except along the fuscous radial edge; face with ivory transverse area between eyes covering basal third, apical two thirds sooty black except apex of clypellus and genae, yellowish, and a red spot above each antennal base; venter fuscous except paler coxo-femoral joints of hind legs, the pale male plates except their outer basal angles,

and the pale legs except for the dark femoral bases, the tarsal claws, and a vague dark area on the hind tibiae. Occasionally males are less well marked and generally of a paler hue, with pale areas more extensive on the pronotum and fore wings.

Female. Entire dorsum yellowish to white, an arcuate transverse line between eyes on crown, an indefinite transverse area on anterior disc of pronotum, a basal, a middle and an apical spot in each clavus, three similarly located spots in each corium along the claval suture, a small spot near base of costal plaque, a large spot at base of inner apical cells which occasionally becomes a transverse blotch extending across base of all apical cells, yellow; face and venter entirely straw-yellow except dark tarsal apices.

Described from a series of twenty-five specimens from Summit, Panama Canal Zone, taken on *Cecropia* (plant host) by N. L. H. Krauss, August 27, 1946 except one female paratype taken in September of the same year. Holotype male, allotype female, seven paratype males and five paratype females in U. S. N. M. collection; six paratype males and five paratype females in the Snow Entomological Collection at Kansas University.

Genus *Beamerana,* nov.

(Pl. 37, fig. 96)

Type of the genus, *Erythroneura tropicalis* Osborn.

Hind wings: vein 1V branching from vein 2V near its base; submarginal vein present, extending around wing apex and confluent with apex of vein "R + M"; vein Cu_1 fused with apical portion of vein M_{3+4} (vein Cu_1 appears unbranched apically); vein Cu_2 confluent with submarginal vein near midlength of wing.

Fore wings: inner apical cell elongate, parallel-sided, its angulate base more proximad than bases of second and third apical cells, its apex attaining wing apex; second and third apical cells elongate, parallel-sided, sessile basally, their bases forming a continuous transverse line; outer apical cell elongate, open basally, not attaining wing apex.

Genital capsule: male plate without a distinct group of macrosetae, with a group of microsetae on basal portion of distal half (concealed by pygofer hook in drawing); pygofer in lateral aspect with posterior margin declivous, lacking conspicuous posterodorsal lobe, with posterior margin broadly thickened to form heavily sclerotized V-shaped bar with apex thickened in transverse plane and bilobed; ventral margin of pygofer overhanging and concealing all but ex-

treme apex of plate in lateral aspect; surface of pygofer lacking setae.

Internal male genitalia: style elongate, slender, without preapical lobe or apical extension, apical portion smoothly curved dorsolaterad and tapered to point, with few macrosetae irregularly arranged on narrowed curved apex and pair of lateral preapical macrosetae; connective triangular with margins concave, with central Y-shaped thickened portion; aedeagal articulation subterminal; aedeagus greatly elongate, narrow, tapering to acute apex, highly ornamented; a lateral cusp each side near base of dorsal apodeme, its apex directed posterodorsad, a number of setiform excrescences beginning ventrally on shaft just distad of cusps, extending dorsad then ventrad in sinuous curve along length of shaft, ending subapically, extreme apex completely, and dorsal portion of apical two thirds, adorned with ornamentations similar in appearance to fish-scales, a few smaller scalelike markings on lateroventral portion of shaft before midpoint; aedeagal apodeme well developed; genital atrium near aedeagal articulation with connective, the preatrium thus very short; gonopore subapical; anal hooks slender, heavily sclerotized, extending ventrad, not intimately associated with pygofer wall.

The genus is known only from the type of the genus, a Bolivian species. It is a slender leafhopper with the eyes large and the head well produced medially. The median length of the crown greatly exceeds the distance between the eyes. The disc of the crown is distinctly depressed. The median length of the head is approximately equal to the median length of the pronotum. The lateral margins of the pronotum, in dorsal aspect, are very short, the posterior margin shallowly emarginate. In lateral aspect, the crown is sharply rounded to the face which is convex and divergent from the line of the dorsum. The width of the pleural portion of the pronotum is greater than the width of the ocellocular area.

The wings were described and illustrated from the holotype of *Erythroneura similis* Osborn, which is a synonym of the genotype. Intact wings were not found on the holotype or the single paratype of the type species.

To Professor R. H. Beamer, of Kansas University, who has devoted the better part of a lifetime to making contributions and assisting others to make contributions to our knowledge of the Homoptera, this genus is enthusiastically dedicated.

Beamerana tropicalis (Osborn), 1928a: 288 (*Erythroneura*), new combination
similis (Osborn), 1928a: 289 (*Erythroneura*), new synonymy

Genus *Empoasca* Walsh

(Pl. 38, fig. 97)

Empoasca Walsh. Prairie Farmer, vol. 10 no. 10, p. 149. 1862.
Chloria Fieber (*nec* Schiner 1862). Verh. zool.-bot. Ges. Wien, vol. 16, p. 508. 1866.
Kybos Fieber. Verh. zool.-bot. Ges. Wien, vol. 16, p. 508. 1866.
Chlorita Fieber. Kat. Eur. Cic., p. 14, 1872 (new name for *Chloria* Fieber *nec* Schiner).
Cybus Douglas. Ent. Mo. Mag., vol. 12, p. 26. 1875.
Hebata LeDong. U. S. Dept. Agr. Tech. Bull. 231: 32. 1931.

Type of the genus, *Empoasca viridescens* Walsh, 1862, which is a synonym of *Tettigonia fabae* Harris, 1841.

Hind wings: vannal veins separate apically; submarginal vein extending around wing apex to apex of vein "R + M" and confluent with this vein; apex of vein Cu_1 confluent with apical portion of vein M_{3+4} (vein Cu_1 appears unbranched apically); vein Cu_2 confluent with submarginal vein in basal half of wing.

Fore wings: venation quite variable interspecifically and intraspecifically, often somewhat variable between two wings of same specimen; inner and outer apical cells not attaining wing apex; second and third apical cells sessile, or triangular, or even short stalked.

Genital capsule: male plate usually well provided with macrosetae in various arrangements but seldom uniseriate, frequently with numerous microsetae in addition, these occasionally very elongate, thin and delicate, plate often with peglike setae in addition, these usually occurring near base of plate; pygofer usually without macrosetae, with microsetae variously arranged; pygofer hooks arising from anteroventral pygofer wall, varied in length and form, seldom wanting; anal hooks present and of various forms.

Internal male genitalia: style without preapical lobe or apical extension, usually elongate, slender, gradually tapering and curved posterolaterad, usually provided with setae along length, apical portion serrate on mesal margin in most of described species, extreme apex usually truncate or concave when observed at very high magnifications; connective typically papilionaceous in form; aedeagus with preatrium elongate, shaft usually very short, occasionally with preatrial paired processes or processes from base of shaft.

The head, in dorsal aspect, varies from blunt and parallel-margined to well produced medially. In lateral aspect, the line of the face is always divergent from the line of the dorsum. The species are usually some shade of yellow or green, occasionally marked with red or chalky white, and occasionally mottled on the dorsum. The writer is indebted to Mr. Paul Christian for the observation that in

the paler species of *Empoasca*—those which may easily be confused with other typhlocybine genera in gross examination—the species of *Empoasca* almost invariably have some green color on the legs, whereas other genera do not, a feature which permits ready recognition in the field.

The genus is a large and difficult one, from a taxonomic standpoint. Approximately one-hundred twenty-five species have been carefully studied in the course of this work. In spite of this, the writer is unwilling to attempt to establish subgenera at this time, for the genus is cosmopolitan and the degree of intergradation between species groups can only be conjectured. It seems apparent that many more species remain to be described from the Western Hemisphere than have been described to date.

Empoasca represents a highly specialized group of Typhlocybinae, considered from a morphological, and from a biological standpoint. The highly specialized genital structures are almost unique. Reduction in venation of the hind wing has attained a degree surpassed only by *Idona* and *Typhlocybella* in the Dikraneurini. Host plant specialization is quite common and many of the mosts are herbaceous.

DeLong (1931b) erected *Hebata* and *Idona* as subgenera in addition to the typical subgenus, and recognized subgenus *Kybos* Fieber. *Idona* has been placed in the Dikraneurini in the present treatment. The head-shape characters used for the subgenera by DeLong are not very useful criteria. Careful study, at very high magnification, has revealed a slight difference in the shape of the extreme style apex between the subgenotypes of *Empoasca* and *Hebata*, and most of the Nearctic forms examined revealed little in the way of intergrades. But supporting characters could not be found, and in the absence of any evidence that the differences in style apices separate natural groups, and also in view of the torturous technique involved in getting the style apex perfectly oriented, there seems no reason for not abandoning *Hebata* as a synonym, as Dr. DeLong and his coworkers seem to have concluded since the establishment of *Hebata*, for this subgenus was not considered in their subsequent work.

The *smaragdula* group of species, as far as is known, stands well apart from other groups, and may well form a subgenus (*Kybos*) in a later analysis. The species in this group have styles which bear conspicuous long fine hairs, usually quite numerous, and the apical portion of the style curves gradually laterad. At least one of the

apical veins of the fore wing arises from cell R. The species are large.

The *confusa* group also consists of large species. The styles are straight, not curved laterally at their apices, and do not bear numerous long fine hairs. All of the apical veins of the fore wing arise from cell M.

Ribaut (1936b) has shown that an European group including *Cicadula viridula* Fallen is distinct, and Zakhvatkin (1946a) has treated this group as a separate genus.

In the following list of species, those not studied by the writer have been prefixed with an asterisk. Certain species which have been available for study nevertheless do not fit into any of the recognized groups. These species are listed, among those not studied by the writer, in a group of species of uncertain position.

Fabae group

Empoasca abrupta DeLong, 1931b: 48
Empoasca acuminata Wheeler, 1939a: 295
Empoasca alboneura Gillette, 1898a: 743
Empoasca amara Davidson and DeLong, 1939a: 114
Empoasca ancistra Davidson and DeLong, 1939a: 115
Empoasca arator Davidson and DeLong, 1940a: 610
Empoasca arida DeLong, 1931b: 49
Empoasca arta DeLong and Davidson, 1935a: 32
Empoasca aspersa Gillette and Baker, 1895a: 107
Empoasca biarca Davidson and DeLong, 1938a: 92
Empoasca bicuspida Davidson and DeLong, 1938a: 91
Empoasca bidens DeLong, 1932c: 397
Empoasca bifurcata DeLong, 1931b: 40
Empoasca calcara DeLong, 1932c: 398
Empoasca calcea DeLong, 1932c: 395
Empoasca calyxa Oman and Wheeler, 1938a: 140
Empoasca caverna Davidson and DeLong, 1938a: 93
Empoasca cerea DeLong, 1931b: 46
Empoasca chelata DeLong and Davidson, 1936a: 226
Empoasca coccinea (Fitch), 1851a: 63 (*Empoa*) (*fide* Oman)
Empoasca convergens DeLong and Davidson, 1935a: 30
Empoasca crepidula Wheeler, 1939a: 294
Empoasca curvata Poos, 1933a: 177
Empoasca curvatura Davidson and DeLong, 1938a: 90
Empoasca decora DeLong and Davidson, 1935a: 33
Empoasca decurvata Davidson and DeLong, 1938a: 93
Empoasca delongi Poos, 1933a: 175
Empoasca delta Wheeler, 1939a: 299
Empoasca deluda DeLong, 1931b: 46
Empoasca denaria Van Duzee, 1930a: 148
Empoasca dentata DeLong and Davidson, 1935a: 30
Empoasca dilitara DeLong and Davidson, 1935a: 36

Empoasca ditata DeLong and Caldwell, 1934a: 606
Empoasca diverta DeLong and Davidson, 1935a: 31
Empoasca dorothyae Davidson and DeLong, 1939a: 111
Empoasca elongata DeLong, 1931b: 53
Empoasca erigeron DeLong, 1931b: 48
Empoasca erythrocephala Wheeler, 1939a: 295
Empoasca fabae (Harris), 1841a: 186 (*Tettigonia*) (*fide* Van Duzee)
Empoasca fabalis DeLong, 1930a: 92
batatae Poos, 1933a: 176
Empoasca filimenta DeLong, 1931b: 43
Empoasca galluxa Davidson and DeLong, 1939a: 117
Empoasca gampsoa Davidson and DeLong, 1939a: 118
Empoasca kaibaba Davidson and DeLong, 1939a: 115
Empoasca manda Davidson and DeLong, 1939a: 111
Empoasca mexicana Gillette, 1898a: 737
Empoasca neaspersa Oman and Wheeler, 1938a: 138
Empoasca nigra Gillette and Baker, 1895a: 108
Empoasca ocala Davidson and DeLong, 1939a: 114
Empoasca occidentalis DeLong and Davidson, 1935a: 32
Empoasca oculea (Osborn), 1928a: 268 (*Dikraneura*), new combination
Empoasca panda DeLong, 1931b: 51
Empoasca pergrada Davidson and DeLong, 1938a: 93
Empoasca perlonga Davidson and DeLong, 1938a: 92
Empoasca plebeia DeLong and Davidson, 1935a: 34
Empoasca ponderosa DeLong and Davidson, 1935a: 29
Empoasca radiata Gillette, 1898a: 738
Empoasca ratio DeLong and Davidson, 1935a: 36
Empoasca recta DeLong and Caldwell, 1934a: 606
Empoasca recurvata DeLong, 1931b: 38
Empoasca rubrarea Wheeler, 1939a: 295
Empoasca ruficeps Van Duzee, 1917a: 304
Empoasca sativae Poos, 1933a: 174
Empoasca similis DeLong and Davidson, 1935a: 37
Empoasca solana DeLong, 1931b: 50
Empoasca spiculata Oman and Wheeler, 1938a: 141
Empoasca tamiama Davidson and DeLong, 1939a: 117
Empoasca tincta DeLong, 1931b: 54
Empoasca torqua DeLong and Davidson, 1935a: 35
Empoasca ulusa Davidson and DeLong, 1942a: 105
Empoasca unca DeLong and Davidson, 1935a: 35
Empoasca varaspina Oman and Wheeler, 1938a: 141
Empoasca vastitatis Oman and Wheeler, 1938a: 136
Empoasca vergena DeLong and Caldwell, 1934a: 607
Empoasca vermispina Oman and Wheeler, 1938a: 137
Empoasca xerophila Oman and Wheeler, 1938a: 142

Smaragdula group

Empoasca adunca DeLong, 1931b: 31
Empoasca aureo-viridis (Uhler), 1877a: 474 (*Typhlocyba*)
Empoasca carsona DeLong and Davidson, 1936a: 229
Empoasca clypeata Gillette and Baker, 1895a: 108

Empoasca copula DeLong, 1931b: 27
Empoasca digita DeLong, 1931b: 26
Empoasca gelbata DeLong and Davidson, 1936a: 225
Empoasca grosata DeLong and Davidson, 1936a: 228
Empoasca incida DeLong, 1931b: 21
Empoasca jacinta DeLong and Davidson, 1936a: 227
Empoasca livingstonii Gillette, 1898a: 728
Empoasca luda Davidson and DeLong, 1938a: 94
Empoasca obtusa Walsh, 1864a: 317 (*fide* Oman)
Empoasca patula DeLong, 1931b: 22
Empoasca reflexa DeLong, 1932c: 396
Empoasca rubrafacia DeLong, 1932c: 394
Empoasca rubrata DeLong and Davidson, 1936a: 226
Empoasca salicis Wheeler, 1937a: 148
Empoasca saluta DeLong, 1931b: 24
Empoasca smaragdula (Fallén), 1806a: 37 (*Cicada*) (*fide* Van Duzee)
Empoasca ziona DeLong and Davidson, 1936a: 227

Confusa group

Empoasca apata DeLong and Davidson, 1936a: 228
Empoasca atrolabes Gillette, 1898a: 736
Empoasca bipunctata (Oshanin), 1871a: 212 (*Chlorita*) (*fide* Oman)
Empoasca confusa DeLong and Davidson, 1936a: 229
Empoasca maligna (Walsh), 1864a: 317 (*Chloroneura*) (*fide* Van Duzee)
Empoasca obrudens DeLong, 1932c: 393
Empoasca pergandei Gillette, 1898a: 735
Empoasca unica Provancher, 1890b: 340

Empoasca species of uncertain position

°Empoasca acantha Davidson and DeLong, 1943a: 216
°Empoasca acodens DeLong, 1931b: 16
°Empoasca adexa Davidson and DeLong, 1943a: 216
°Empoasca albolinea Gillette, 1898a: 732
°Empoasca albonota DeLong, 1931b: 43
°Empoasca alboscripta Van Duzee, 1914a: 56
°Empoasca amblacantha Oman and Wheeler, 1938a: 140
°Empoasca arqua Davidson and DeLong, 1942a: 106
°Empoasca aspra Davidson and DeLong, 1943a: 218
°Empoasca barbara Hartzell, 1923a: 107
°Empoasca bicorna DeLong and Caldwell, 1934a: 604
°Empoasca bispinata Davidson and DeLong, 1943a: 216
°Empoasca bitubera DeLong, 1932c: 395
Empoasca breviceps (Osborn), 1928a: 271 (*Dikraneura*), new combination
alebroidea (Osborn), 1928a: 271 (*Dikraneura*), new combination, new synonymy
°Empoasca brevidens DeLong *in* Wolcott, 1923b: 269
°Empoasca bulba Davidson and DeLong, 1943a: 218
°Empoasca caldwelli Davidson and DeLong, 1943a: 215
°Empoasca camara Davidson and DeLong, 1942a: 108

*Empoasca canalis (Osborn), 1928a: 282 (*Joruma*), new combination (according to Dr. Oman)
*Empoasca canavalia DeLong, 1932b: 114
*Empoasca caraba Davidson and DeLong, 1943a: 214
*Empoasca cerata Davidson and DeLong, 1943a: 215
*Empoasca chromata Davidson and DeLong, 1942b: 123
*Empoasca cothurna Davidson and DeLong, 1943b: 639
*Empoasca crocostigmata Davidson and DeLong, 1942b: 124
*Empoasca crocovittata Davidson and DeLong, 1942b: 124
*Empoasca curveola Oman, 1936a: 40
*Empoasca curvexa Davidson and DeLong, 1939a: 110
*Empoasca dactylata Davidson and DeLong, 1942b: 126
*Empoasca dampfi Davidson and DeLong, 1940a: 608
*Empoasca davidsoni DeLong, 1944a: 272
Empoasca decorata Osborn, 1924c: 452
*Empoasca denticula Gillette, 1898a: 734
*Empoasca diacumanis Davidson and DeLong, 1943b: 638
*Empoasca distracta DeLong and Caldwell, 1934a: 607
*Empoasca dolonis Oman, 1936a: 39
*Empoasca duodens Davidson and DeLong, 1940a: 611
*Empoasca ellissae Wheeler, 1937a: 148
*Empoasca emarginata Osborn, 1928a: 286
*Empoasca ensiformis Oman and Wheeler, 1938a: 142
*Empoasca esuma Goding, 1890b: 116
*Empoasca excava Davidson and DeLong, 1938a: 94
*Empoasca falca DeLong and Davidson, 1935a: 34
Empoasca fasciata (Osborn), 1928a: 273 (*Dikraneura*), new combination
Empoasca fulvomaculata (Osborn), 1928a: 255 (*Alebra*), new combination
*Empoasca fuscoviridis Oman and Wheeler, 1938a: 147
*Empoasca gigantica Davidson and DeLong, 1943a: 220
*Empoasca gleditsia DeLong and Davidson, 1936a: 225
*Empoasca goodi Davidson and DeLong, 1943a: 220
*Empoasca gossypii DeLong, 1932b: 114
*Empoasca guatemalana (Osborn), 1928a: 282 (*Joruma*), new combination (according to Dr. Oman, unpublished)
*Empoasca hama DeLong and Caldwell, 1934a: 605
*Empoasca hamata DeLong, 1931b: 43
*Empoasca hecta Davidson and DeLong, 1939a: 116
Empoasca hyalina (Osborn), 1928a: 284 (*Joruma*), new combination
*Empoasca indenta Oman and Wheeler, 1938a: 139
*Empoasca ingena Davidson and DeLong, 1942a: 106
*Empoasca insularis Oman, 1936a: 40
*Empoasca irrita Davidson and DeLong, 1943b: 636
*Empoasca junipera DeLong, 1931b: 51
*Empoasca knulli Davidson and DeLong, 1939a: 111
*Empoasca lata DeLong and Caldwell, 1934a: 606
*Empoasca latarca Davidson and DeLong, 1938a: 91
*Empoasca lauta Davidson and DeLong, 1942a: 105

*Empoasca lineata Baker, 1903d: 7
*Empoasca longispina Oman, 1936a: 37
Empoasca maculosa (Osborn), 1928a: 272 (*Dikraneura*), new combination
*Empoasca madra Davidson and DeLong, 1939a: 116
*Empoasca medora DeLong, 1932c: 397
*Empoasca mesolinea Davidson and DeLong, 1939a: 114
*Empoasca missiona Oman, 1936a: 40
*Empoasca morrisoni Hartzell, 1923a: 107
*Empoasca necyla Davidson and DeLong, 1939a: 110
*Empoasca nema Davidson and DeLong, 1939a: 112
*Empoasca obstipa Davidson and DeLong, 1942a: 108
Empoasca olivatula (Osborn), 1928a: 287
*Empoasca omani Davidson and DeLong, 1942b: 123
Empoasca ornata (Osborn), 1928a: 283 (*Joruma*), new combination
*Empoasca ornatella, new name
ornata Oman, 1936a: 37, new synonymy
*Empoasca orthodens Davidson and DeLong, 1938a: 91
*Empoasca osborni Hartzell, 1923a: 104
*Empoasca pallida Gillette, 1898a: 741
*Empoasca pallidula DeLong, 1931b: 42
*Empoasca papayae Oman, 1937d: 570
*Empoasca pectinata DeLong, 1931b: 16
*Empoasca pelecana Oman and Wheeler, 1938a: 141
*Empoasca peregrina Oman, 1936a: 34
*Empoasca perelegans Oman, 1936a: 35
*Empoasca phaseola Oman, 1936a: 39
*Empoasca photophila (Berg), 1879e: 273 (*Typhlocyba*)
Empoasca picta Osborn, 1924c: 452
Empoasca pictifrons (Osborn), 1928a: 256 (*Alebra*), new combination
*Empoasca pinella Davidson and DeLong, 1939a: 112
*Empoasca prona Davidson and DeLong, 1940a: 610
*Empoasca pyramidata DeLong and Caldwell, 1934a: 608
*Empoasca quintapunctata Davidson and DeLong, 1943b: 638
*Empoasca resupina Davidson and DeLong, 1940a: 611
*Empoasca rubraza Oman, 1936a: 34
Empoasca rubromaculata Osborn, 1928a: 285
*Empoasca rumexa Davidson and DeLong, 1943a: 216
*Empoasca sagitta Davidson and DeLong, 1939a: 112
*Empoasca salinarum (Berg), 1879e: 274 (*Typhlocyba*)
*Empoasca sanguinea (Gillette and Baker), 1895a: 112 (*Typhlocyba*)
*Empoasca semanta Davidson and DeLong, 1943a: 215
*Empoasca serpula Davidson and DeLong, 1943a: 218
*Empoasca serrula Davidson and DeLong, 1940a: 608
*Empoasca setata DeLong and Davidson, 1936a: 226
*Empoasca setigera Oman, 1936a: 37
*Empoasca simplex DeLong and Davidson, 1935a: 37
*Empoasca sinuata Oman and Wheeler, 1938a: 140
*Empoasca snowi Gillette, 1898a: 741

*Empoasca sonorana Wheeler, 1940a: 479
*Empoasca spira DeLong and Caldwell, 1934a: 605
*Empoasca stalsisa Davidson and DeLong, 1943a: 214
*Empoasca strangula Davidson and DeLong, 1939a: 113
*Empoasca stylata Wheeler, 1940a: 480
*Empoasca sublactea Van Duzee, 1917a: 302
*Empoasca tectona Davidson and DeLong, 1943b: 639
Empoasca tergata (McAtee), 1926b: 167 (*Joruma*), new combination
*Empoasca thela Davidson and DeLong, 1939a: 113
*Empoasca transversa Van Duzee, 1917a: 303
*Empoasca trifasciata Gillette, 1898a: 726
*Empoasca trifurcata Oman, 1936a: 39
*Empoasca trilobata DeLong, 1931b: 17
*Empoasca tripunctata Davidson and DeLong, 1943b: 636
*Empoasca utrica Davidson and DeLong, 1939a: 117
*Empoasca uvalda Davidson and DeLong, 1939a: 115
°Empoasca valvata Osborn, 1923a: 76 (?) (*Cicadula*) (according to Dr. Oman, unpublished)
*Empoasca venusta DeLong and Davidson, 1935a: 33
*Empoasca vincula DeLong, 1931b: 44
*Empoasca zonalis (Osborn), 1928a: 283 (*Joruma*), new combination (according to Dr. Oman, unpublished)

ADDENDUM

Since the foregoing has been submitted to the editor, several publications on the Typhlocybinae have appeared. These are included in the bibliography at the end of this section, and the species are listed below, in their respective genera. Those species prefixed with an asterisk have not been studied by the writer.

Genus *Parallaxis* McAtee

The species listed below cannot be placed with any certainty, because no males were available for study. The venation of the hind wing suggests a relationship with *Eualebra* in the Typhlocybini, but it seems advisable to retain the species in its original combination until males are studied.

Parallaxis jalapai DeLong and Ruppel, 1951a: 36

Genus *Alconeura* Ball and DeLong

The species not prefixed with an asterisk in the list below were examined before they had manuscript names, through the kindness of Dr. D. M. DeLong.

Alconeura cinctella DeLong and Ruppel, 1951c: 60
Alconeura[1] languida DeLong and Ruppel, 1951c: 57

1. This species, a primary homonym, is to be renamed by its author in a publication now in press.

Alconeura rubella DeLong and Ruppel, 1951c: 61
Alconeura rubranota DeLong and Ruppel, 1951c: 59
Alconeura separata DeLong and Ruppel, 1951c: 58
Alconeura similis DeLong and Ruppel, 1951c: 62
* Alconeura splendida Knull, 1951a: 169

Erythroneura subg. *Erasmoneura* Young

* Erythroneura fiduciaria Knull, 1951a: 170

Erythroneura subg. *Erythridula* Young

* Erythroneura ampla Knull, 1951b: 179
* Erythroneura enata Knull, 1951b: 179
* Erythroneura freta Knull, 1951b: 179
* Erythroneura tolerata Knull, 1951b: 180

Erythroneura subg. *Eratoneura* Young

* Erythroneura acantha Ross and DeLong, 1950a: 296
* Erythroneura arenosa Ross and DeLong, 1950a: 295
* Erythroneura coxi Ross and DeLong, 1950a: 295
* Erythroneura cristata Knull, 1951a: 174
* Erythroneura fausta Knull, 1951a: 172
* Erythroneura igella Ross and DeLong, 1950a: 295
* Erythroneura maga Knull, 1951a: 170
* Erythroneura millsi Ross and DeLong, 1950a: 291
* Erythroneura quercalbae Ross and DeLong, 1950a: 294
* Erythroneura rangifer Ross and DeLong, 1950a: 292
* Erythroneura spala Ross and DeLong, 1950a: 294
* Erythroneura spinea Knull, 1951a: 172
* Erythroneura stoveri Ross and DeLong, 1950a: 296
* Erythroneura tenilla Ross and DeLong, 1950a: 294
* Erythroneura tersa Knull, 1951a: 172

Genus *Scinda* DeLong and Ruppel

Cicadella (*Scinda*) DeLong and Ruppel. Ohio Journ. Sci., vol. 51, p. 95. 1951. new status.

The species listed below are correctly placed in Typhlocybini, and are sufficiently distinct from *Eupteryx* Curtis to justify full generic status. Further study is needed to establish points of difference between this group of species and *Eupterella* DeLong and Ruppel, which is very closely related, if not identical.

* Scinda circula DeLong and Ruppel, 1951b: 96
* Scinda cochlea DeLong and Ruppel, 1951b: 96
* Scinda cordoba DeLong and Ruppel, 1951b: 96
* Scinda scarlatine DeLong and Ruppel, 1951b: 95

Genus *Empoasca* Walsh

Empoasca mira Knull, 1951a: 169

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PLATE 1

(Used Through the Courtesy of P. W. Oman)

FIG. 1. A deltocephaline leafhopper, showing the structures of the dorsum.

FIG. 2. A deltocephaline leafhopper, showing the structures of the face.

FIG. 3. A deltocephaline leafhopper, terminus of venter, female, showing structure of the external genitalia.

FIG. 4. A deltocephaline leafhopper, terminus of venter, male, showing the structure of the external male genitalia.

PLATE 1

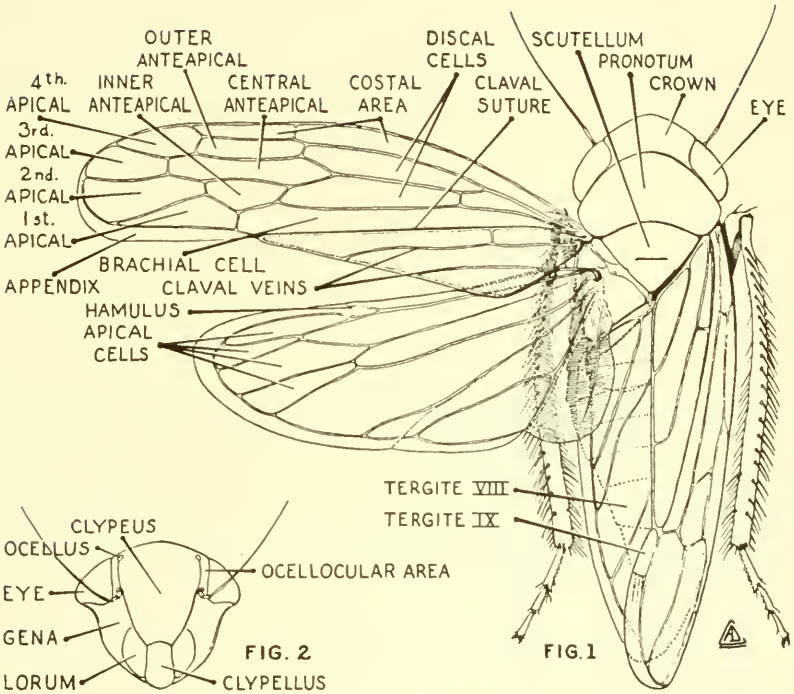

OUTER ANTEAPICAL
DISCAL CELLS
SCUTELLUM
PRONOTUM
CROWN
EYE
4th. APICAL
INNER ANTEAPICAL
CENTRAL ANTEAPICAL
COSTAL AREA
CLAVAL SUTURE
3rd. APICAL
2nd. APICAL
1st. APICAL
BRACHIAL CELL
APPENDIX
CLAVAL VEINS
HAMULUS
APICAL CELLS
TERGITE VIII
TERGITE IX
CLYPEUS
OCELLUS
OCELLOCULAR AREA
EYE
GENA
LORUM
CLYPELLUS
FIG. 2
FIG. 1
STERNITE VII
PYGOFER
♀
FIG. 3
VALVE
PLATE
PYGOFER
♂
FIG. 4

PLATE 2

FIG. 5. A typhlocybine leafhopper, hind wing, showing the wing veins.

FIG. 6. A typhlocybine leafhopper, fore wing, showing some of the veins used in the present classification.

FIG. 7. A hypothetical typhlocybine aedeagus, showing structures used in this classification.

FIG. 8. *Dikrellidia bilineata*, right style and connective, dorsal aspect ($\times$ 286), showing structures used in classification.

PLATE 2

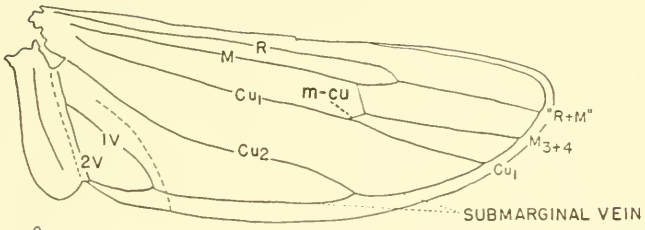


FIG.5. HIND WING

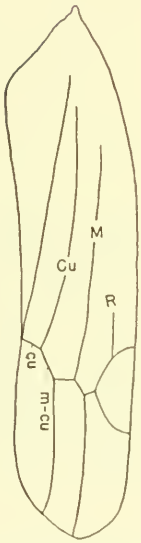


FIG.6. FORE WING

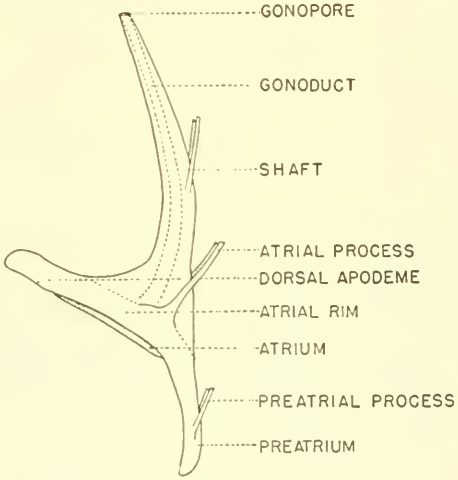


FIG.7.
AEDEAGUS, SCHEMATIC

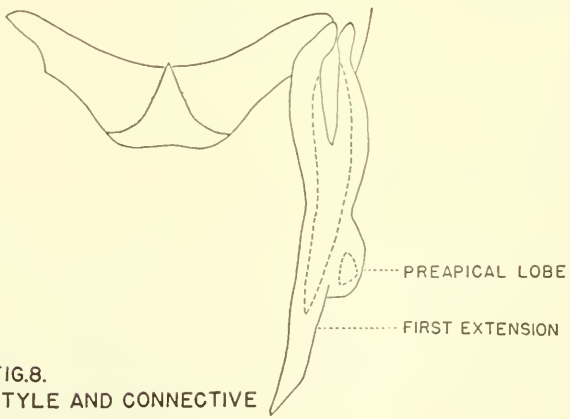


FIG.8.
STYLE AND CONNECTIVE

PLATE 3

FIG. 9. *Zygina scutellaris,* apex of right style, broad aspect (× 286).

FIG. 10. *Erythroneura mansueta,* apex of right style, broad (dorsal) aspect (× 286).

FIG. 11. *E. bifurca,* apex of right style, broad (dorsal) aspect (× 286).

FIG. 12. *E. idonea,* apex of right style, broad (dorsal) aspect (× 286).

FIG. 13. *E. nitida,* apex of right style, broad aspect (× 286).

FIG. 14. *E. aenea,* apex of right style, broad (dorsal) aspect (× 286).

FIG. 15. *E. reflecta,* apex of right style, broad (ventral) aspect (× 286).

PLATE 3

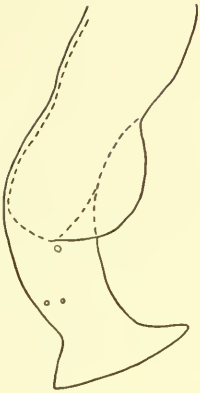


FIG. 9
ZYGINA SCUTELLARIS

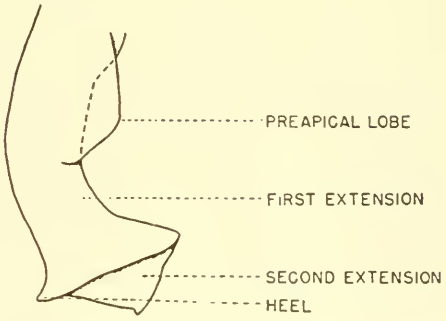


FIG. 10
ERYTHRONEURA MANSUETA

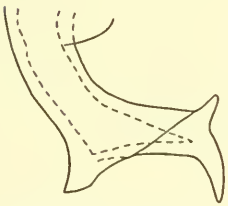


FIG. 11
ERYTHRONEURA
BIFURCA

FIG. 12
ERYTHRONEURA
IDONEA

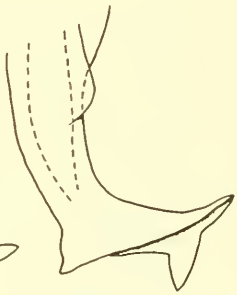


FIG. 13
ERYTHRONEURA
NITIDA

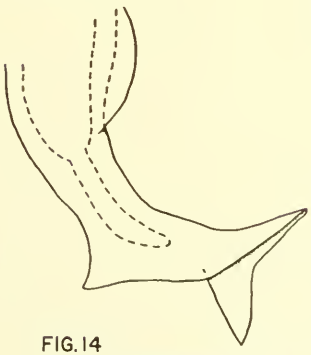


FIG. 14
ERYTHRONEURA AENEA

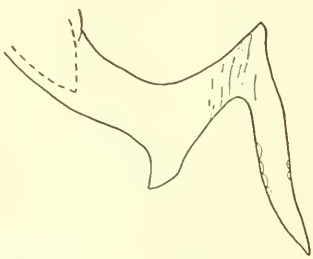


FIG. 15
ERYTHRONEURA REFLECTA

PLATE 4

FIG. 16. *Hadralebra laticeps*

C. Type, male genital capsule, lateral aspect (× 100).
D. Type, right style and connective, dorsal aspect (× 286).
E. Type, aedeagus lateral aspect (× 286).

FIG. 17. *Aphanalebra unipuncta*

A. Hind wing (venation compared with type).
B. Fore wing (venation compared with type).
C. Holotype, male genital capsule, lateral aspect (× 100).
D. Holotype, right style, apical half, dorsal aspect (× 286).
E. Holotype, aedeagus, right lateral aspect (× 134).

PLATE 4

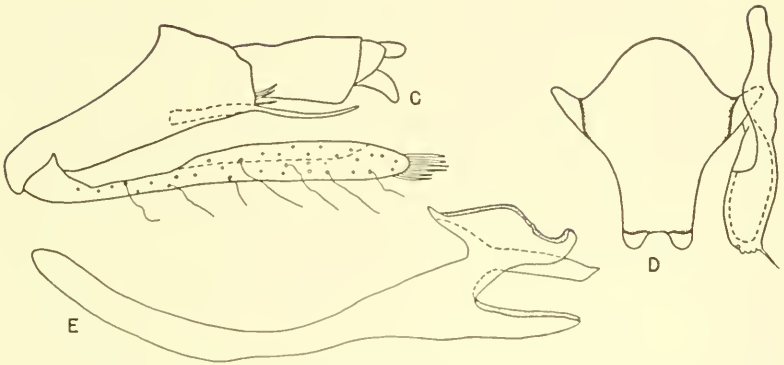


FIG. 16 HADRALEBRA LATICEPS

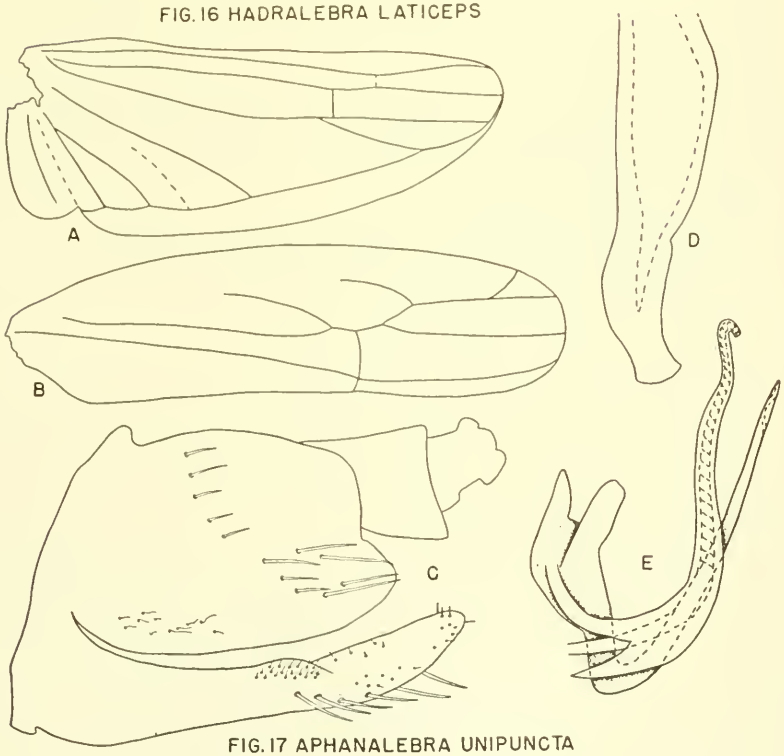


FIG. 17 APHANALEBRA UNIPUNCTA

PLATE 5

FIG. 18. *Rabela tabebuiae*

A. Hind wing.
B. Fore wing.
C. Male genital capsule, lateral aspect, anal tube not shown (× 100).
D. Right style, apical half, broad aspect (× 286).
E. Aedeagus, lateral aspect (× 286).

FIG. 19. *Kallebra ninettae*

B. Fore wing, sketch.
C. Holotype, male genital capsule, lateral aspect (× 100).
E. Holotype, aedeagus, lateral aspect (× 213).

PLATE 5

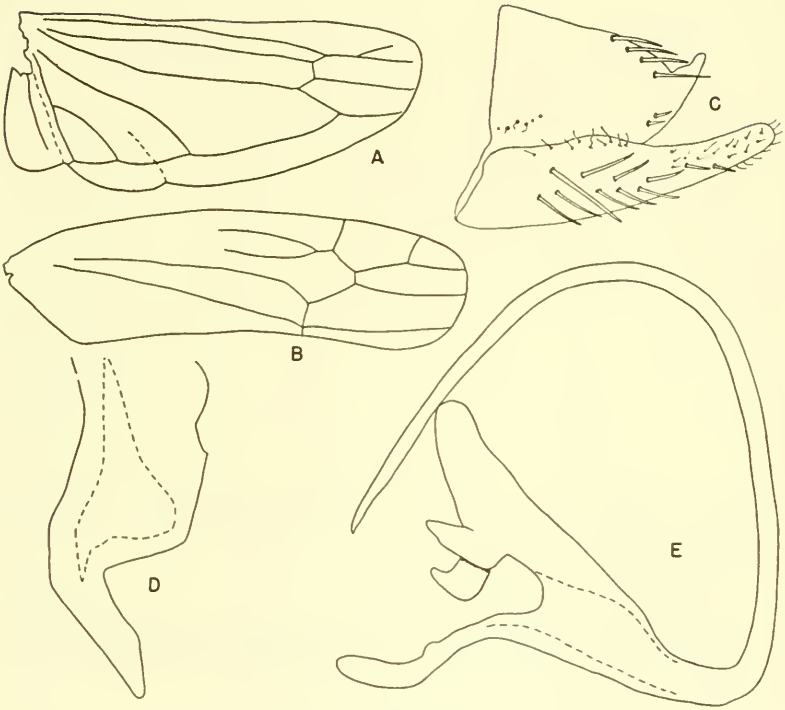


FIG. 18 RABELA TABEBUIAE

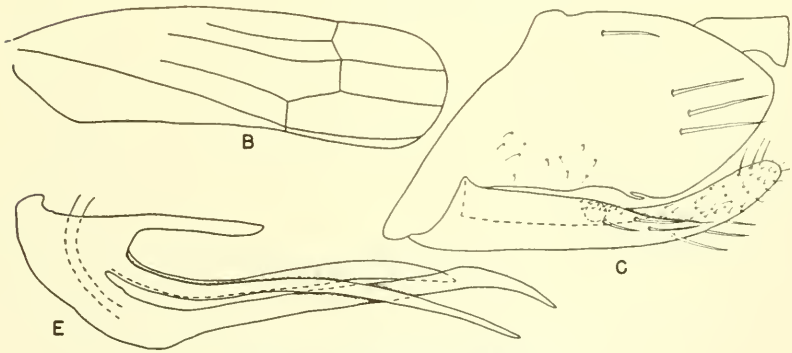


FIG. 19 KALLEBRA NINETTAE

PLATE 6

FIG. 20. *Kallebra ninettae,* holotype, right style, dorsal aspect (× 286).
FIG. 21. *Orsalebra robusta.*
A. Holotype, hind wing.
B. Holotype, fore wing.
C. Holotype, male genital capsule, lateral aspect (× 100).
D. Holotype, right style, apical third, lateral aspect (× 286).

PLATE 6

FIG. 20
KALLEBRA
NINETTAE

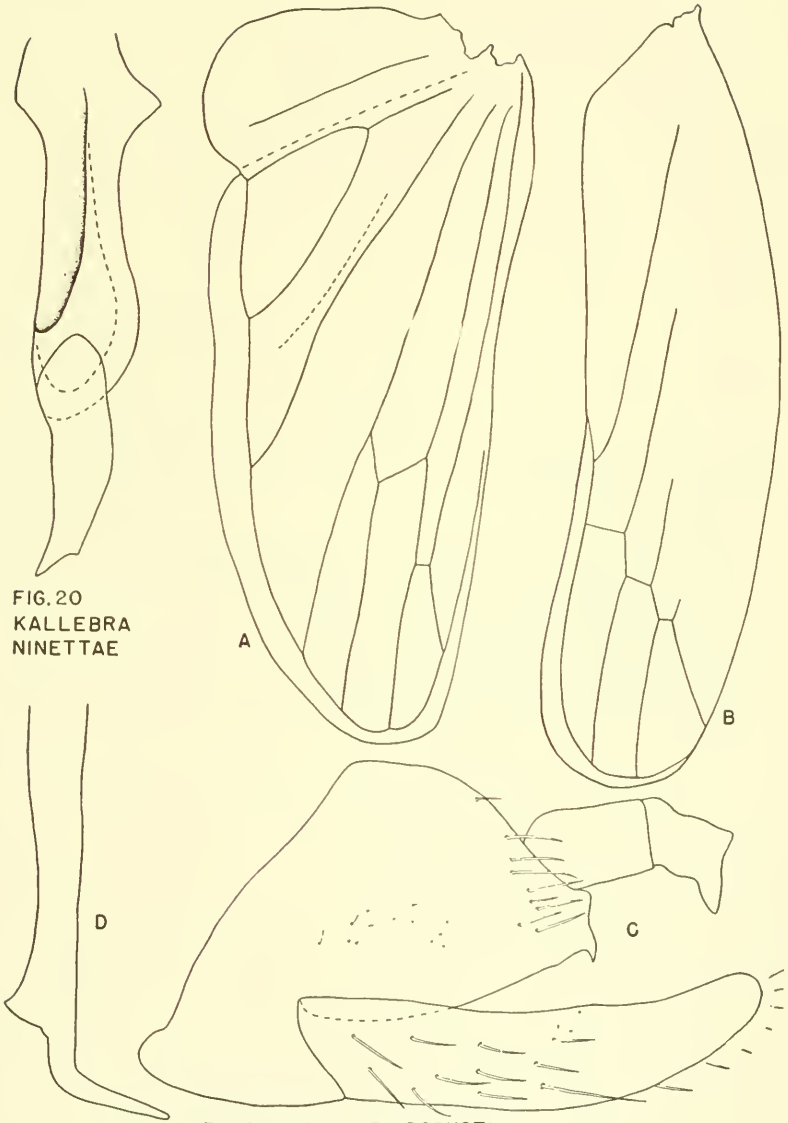


FIG. 21 ORSALEBRA ROBUSTA

PLATE 7

FIG. 22. *Orsalebra robusta,* holotype, aedeagus, lateral aspect (× 100).

FIG. 23. *Balera pellucida*

A. Hind wing.
B. Fore wing.
C. Type, male genital capsule, lateral aspect (× 100).
D. Type, right style, entire, broad aspect (× 286).
E. Type, aedeagus, lateral aspect (× 286).

FIG. 24. *Diceratalebra sanguinolinea*

D. Right style, dorsal aspect (× 286).
E. Aedeagus, lateral aspect (× 286).

PLATE 7

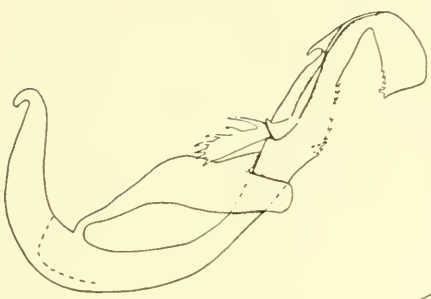
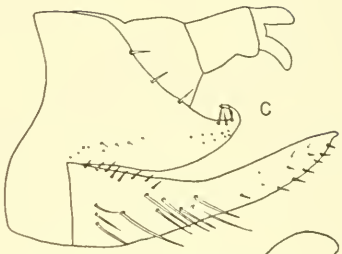


FIG. 22
ORSALEBRA ROBUSTA



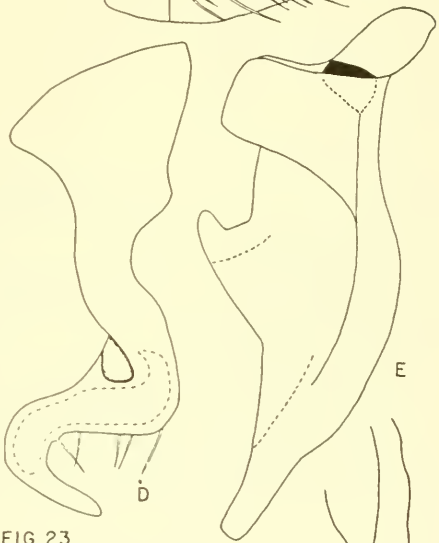


FIG. 23
BALERA PELLUCIDA

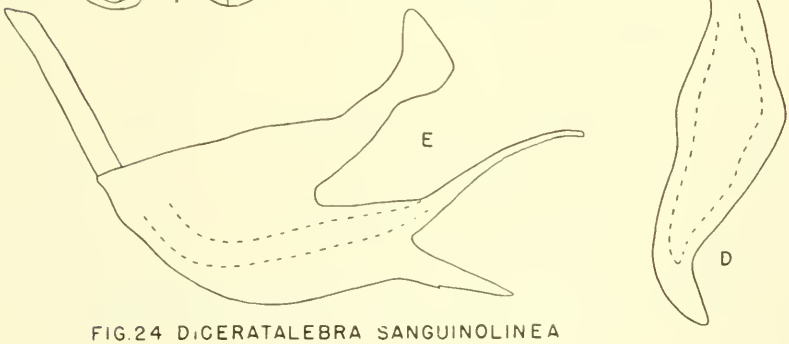


FIG. 24 DICERATALEBRA SANGUINOLINEA

PLATE 8

FIG. 25. *Diceratalebra sanguinolinea*
- A. Hind wing.
- B. Fore wing.
- C. Male genital capsule, lateral aspect (× 100).

FIG. 26. *Trypanalebra*
- A. *Trypanalebra* sp., hind wing.
- B. *Trypanalebra* sp., fore wing.
- C. *Trypanalebra* sp., male genital capsule, lateral aspect (× 100).
- D. *Trypanalebra* sp., right style, dorsal aspect (× 286).
- E. *Trypanalebra* sp., aedeagus, lateral aspect (× 213).

PLATE 8

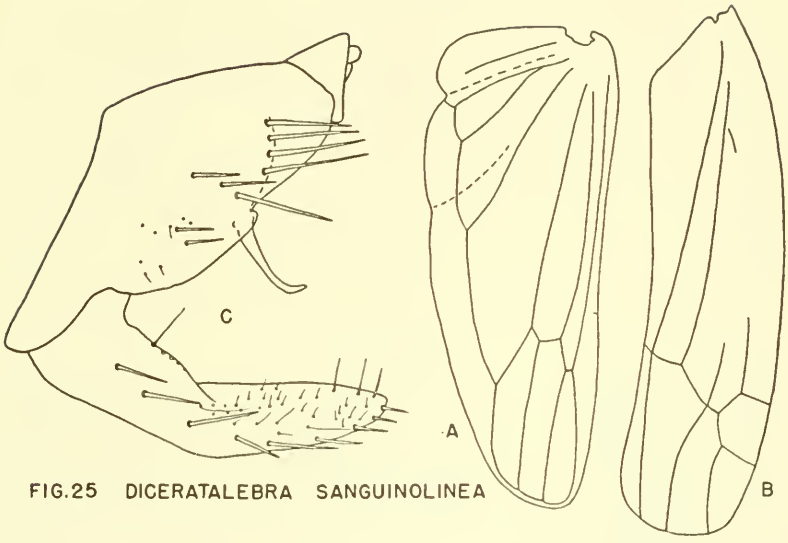


FIG.25 DICERATALEBRA SANGUINOLINEA

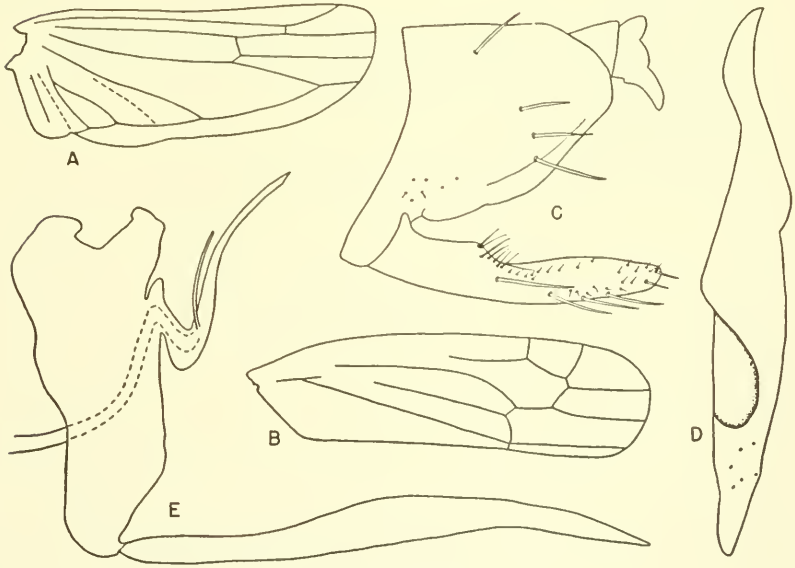


FIG.26 TRYPANALEBRA

PLATE 9

FIG. 27. *Paralebra*

A. *Paralebra* sp. near *similis*, hind wing (venation compared with type of *similis*).

B. *Paralebra* sp. near *similis*, fore wing (venation compared with type of *similis*).

C. *Paralebra similis*, holotype, male genital capsule, lateral aspect (× 100).

D. *Paralebra similis*, holotype, right style, dorsal aspect (× 286).

E. *Paralebra similis*, holotype, aedeagus, lateral aspect (× 286).

F. *Paralebra similis*, paratype, fore wing.

FIG. 28. *Alebra albostriella*

B. Fore wing.

D. Style and connective, dorsal aspect (× 67).

TABLE 9

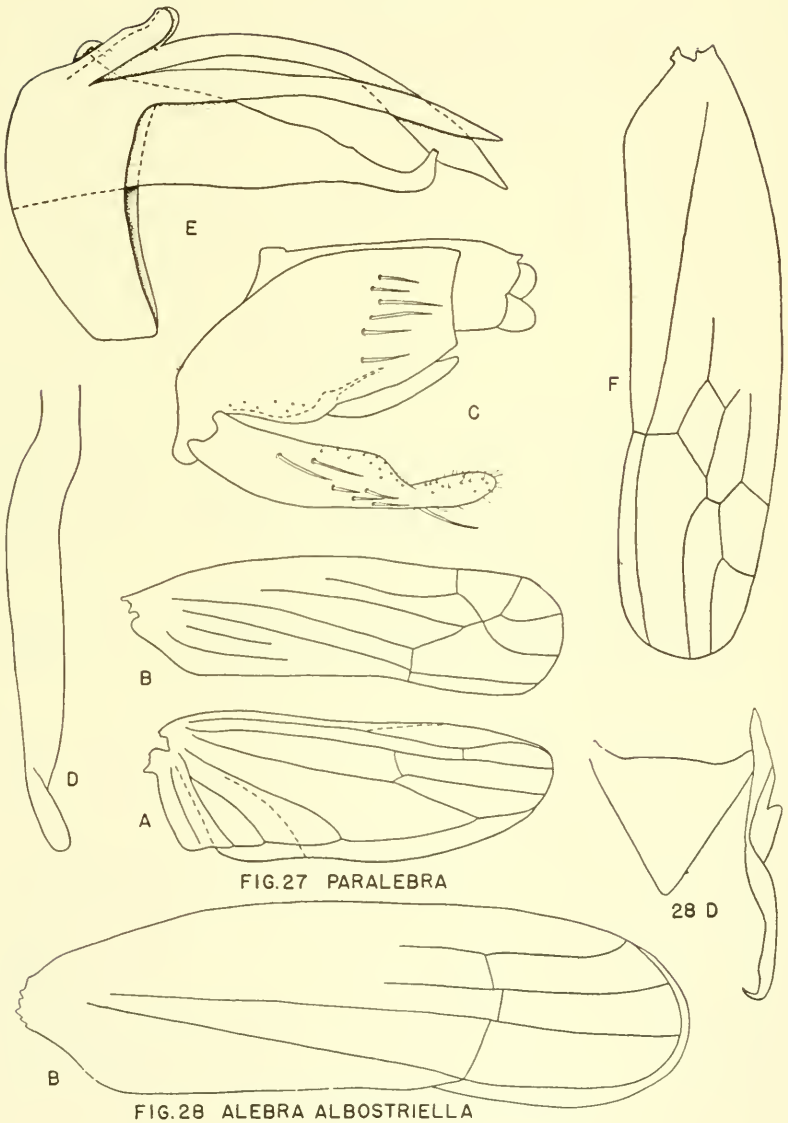


FIG. 27 PARALEBRA

FIG. 28 ALEBRA ALBOSTRIELLA

PLATE 10

FIG. 29. *Alebra albostriella*

A. Hind wing.

C. Male genital capsule, lateral aspect, anal tube not shown (× 100).

E. Aedeagus, lateral aspect (× 100).

FIG. 30. *Brunerella magnifica*

A. Holotype, hind wing.

B. Holotype, fore wing.

D. Holotype, right style, broad aspect (ventrolateral) (×286).

E. Holotype, aedeagus, dorsal aspect (× 286).

PLATE 10

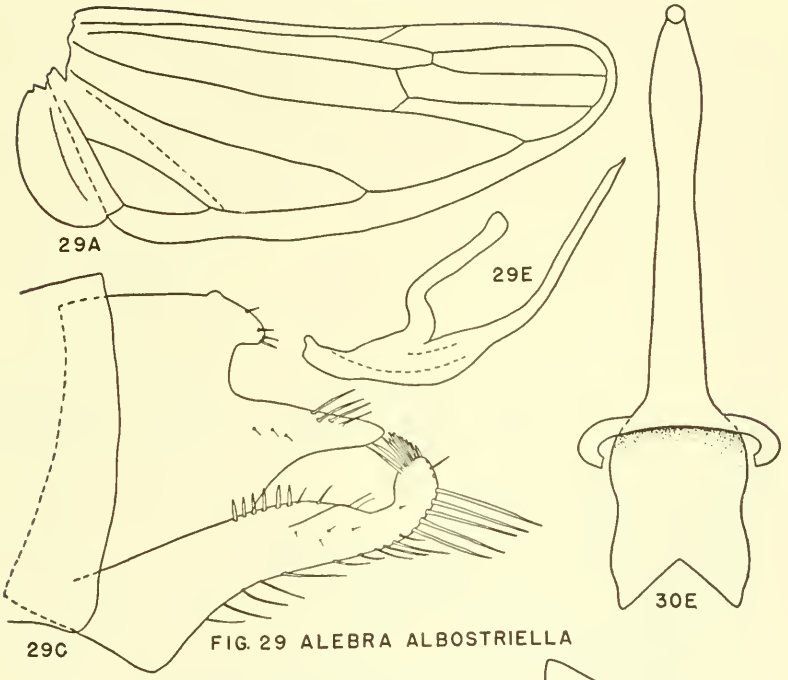


FIG. 29 ALEBRA ALBOSTRIELLA

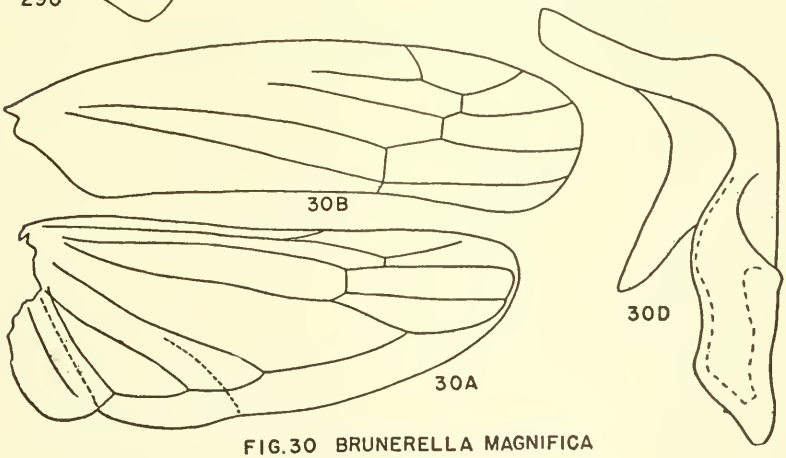


FIG. 30 BRUNERELLA MAGNIFICA

PLATE 11

FIG. 31. *Brunerella magnifica*, holotyye, male genital capsule, lateral aspect (× 100).

FIG. 32. *Habralebra nicaraguensis*

A. Hind wing.
B. Fore wing.
C. Male genital capsule, lateral aspect (× 100).
D. Right style, apical seven ninths, broad aspect (dorsal) (× 286).
E. Aedeagus, lateral aspect (× 286).

FIG. 33. *Elabra eburneola*

D. Right style and connective, dorsal aspect (× 286).
E. Aedeagus, lateral and slightly ventral aspect (× 213).

PLATE 11

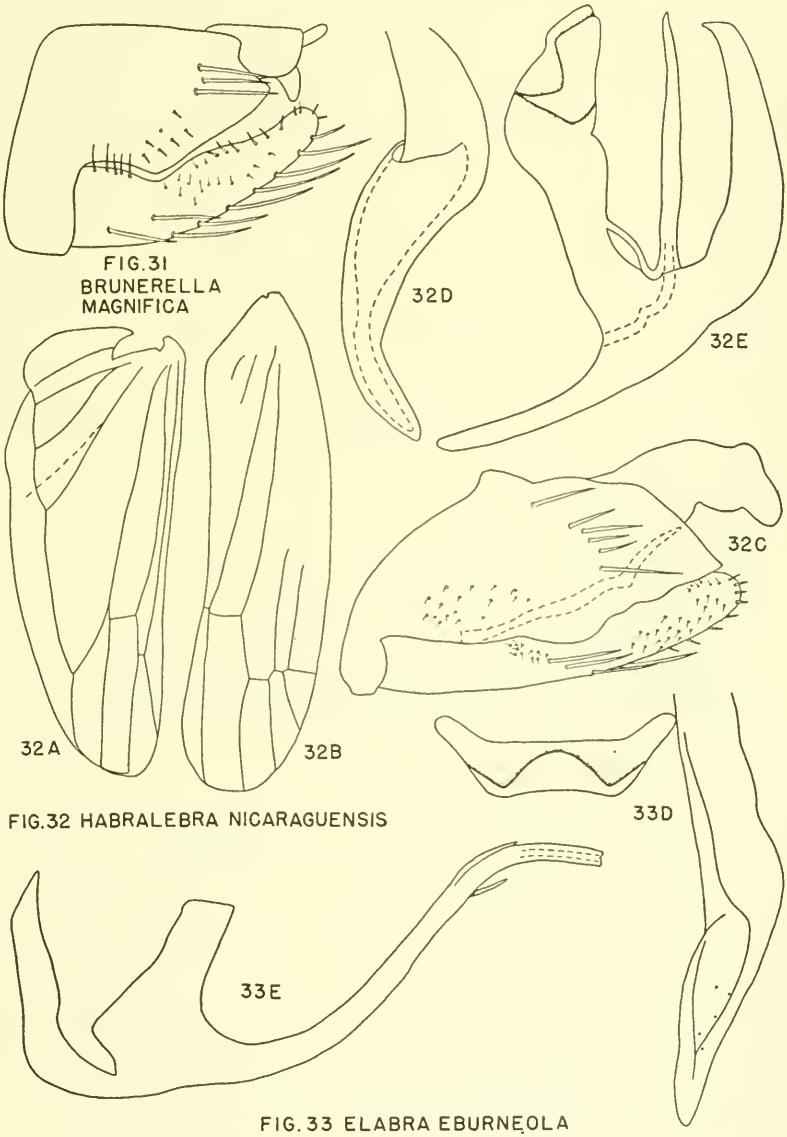


FIG. 31 BRUNERELLA MAGNIFICA

FIG. 32 HABRALEBRA NICARAGUENSIS

FIG. 33 ELABRA EBURNEOLA

PLATE 12

FIG. 34. *Elabra eburneola*
- A. Hind wing.
- B. Fore wing.
- C. Male genital capsule, lateral aspect ($\times$ 100).

FIG. 35. *Rhabdotalebra octolineata*
- A. Hind wing.
- B. Fore wing.
- C. Male genital capsule, lateral aspect, anal tube not shown ($\times$ 100).
- D. Right style apex, apical two-thirds, dorsal aspect ($\times$ 286).

PLATE 12

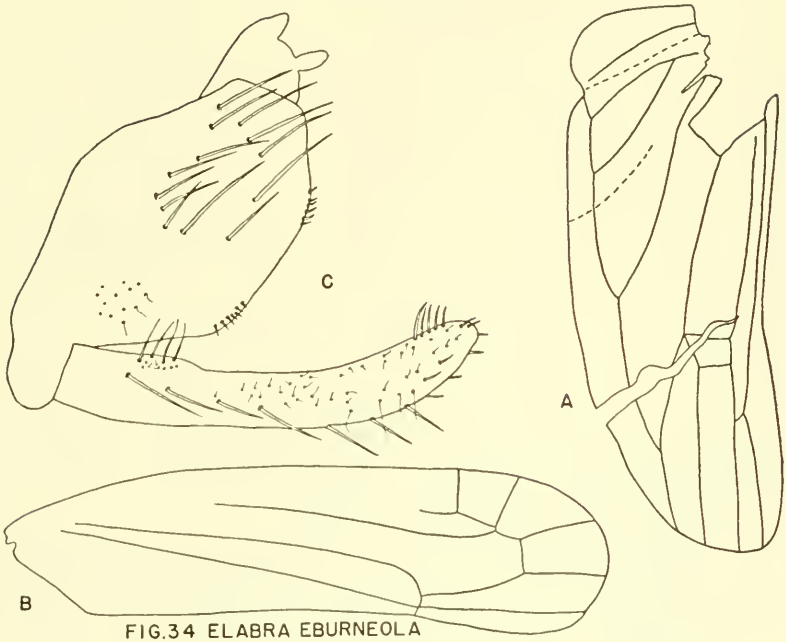


FIG. 34 ELABRA EBURNEOLA

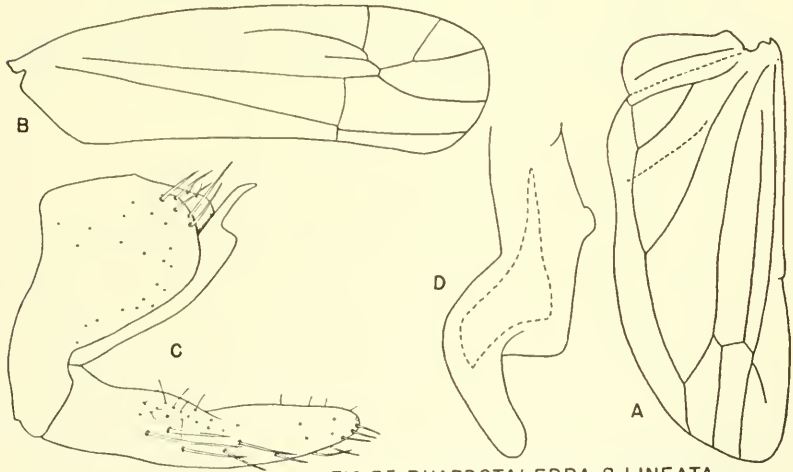


FIG. 35 RHABDOTALEBRA 8-LINEATA

PLATE 13

FIG. 36. *Rhabdotalebra octolineata,* aedeagus, lateral aspect (× 286).

FIG. 37. *Protalebra*

A. *Protalebra* sp. near *curvilinea,* hind wing.

B. *Protalebra* sp. near *curvilinea,* fore wing.

C. *Protalebra curvilinea,* holotype, male genital capsule, lateral aspect (× 100).

D. *Protalebra curvilinea,* holotype, right style, apical half, dorsal aspect (×286).

E. *Protalebra curvilinea,* holotype, aedeagus, lateral aspect (× 213).

FIG. 38. *Protalebrella brasiliensis,* paratype, aedeagus, lateral aspect (×286).

PLATE 13

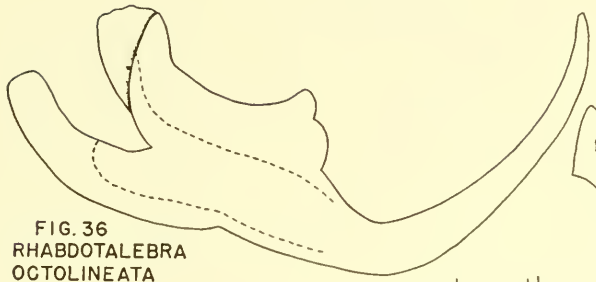
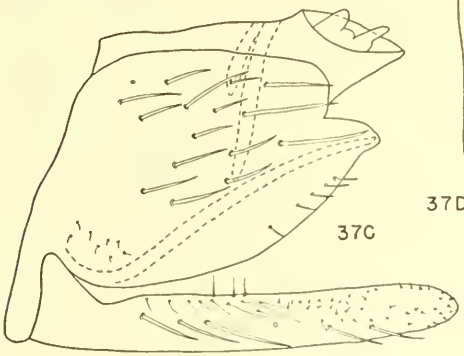
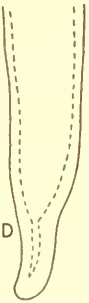


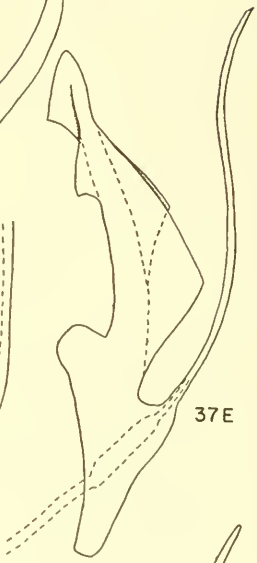
FIG. 36
RHABDOTALEBRA
OCTOLINEATA



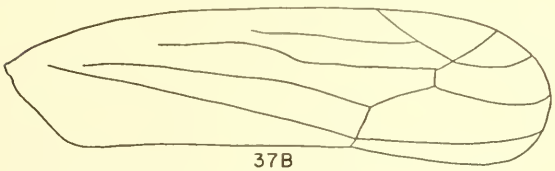
37C



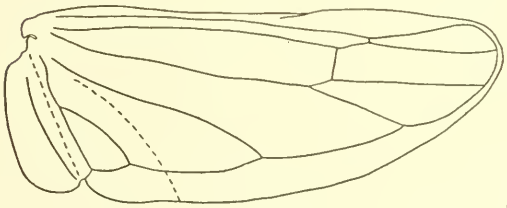
37D



37E



37B



37A

FIG. 37 PROTALEBRA

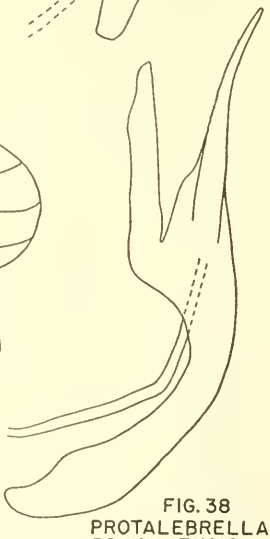


FIG. 38
PROTALEBRELLA
BRASILIENSIS

PLATE 14

FIG. 39. *Protalebrella brasiliensis*

A. Hind wing.
B. Fore wing.
C. Paratype, male genital capsule, lateral aspect (× 100).
D. Paratype, right style (× 286).

FIG. 40. *Dicranoneura loca*

A. Hind wing.
B. Fore wing.
C. Male genital capsule, lateral aspect (× 67).
D. Right style, dorsal aspect (× 100).
E. Aedeagus, lateral aspect (× 100).
F. Male ninth sternum, from within (× 67).

PLATE 14

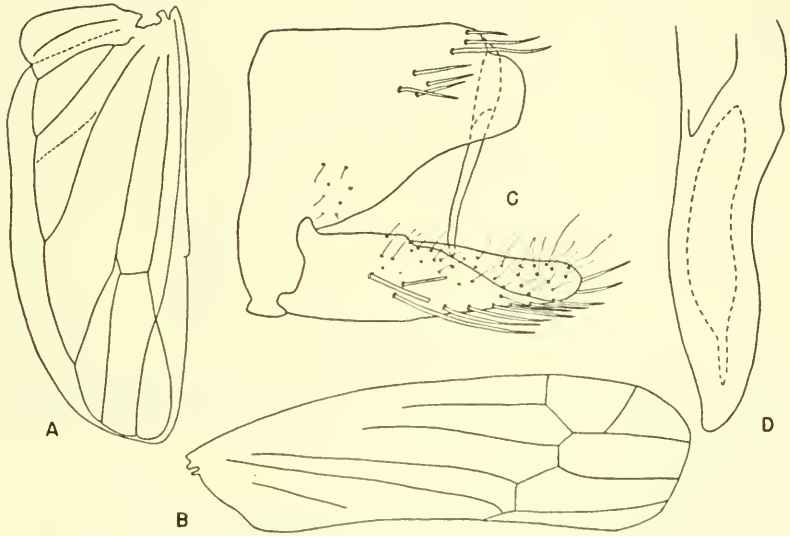


FIG. 39 PROTALEBRELLA BRASILIENSIS

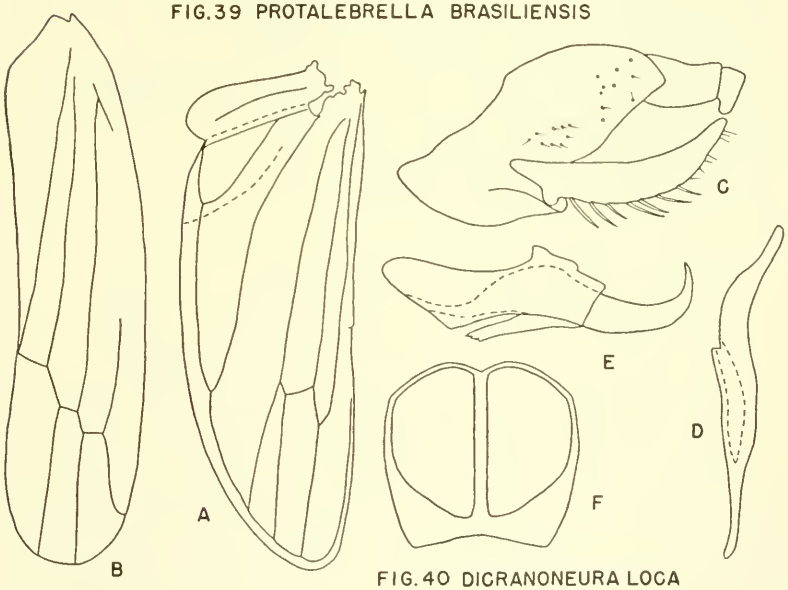


FIG. 40 DICRANONEURA LOCA

PLATE 15

FIG. 41. *Dicranoneura loca,* external male genitalia, from unmacerated specimen.

FIG. 42. *Notus*

A. *Notus alta,* hind wing.
B. *Notus alta,* fore wing.
C. *Notus flavipennis,* male genital capsule, lateral aspect (× 67).
D. *Notus alta,* right style, dorsal aspect (× 286).
E. *Notus alta,* aedeagus, caudal aspect (× 100).
F. *Notus flavipennis,* apex of male abdomen, ventral aspect.
G. *Notus flavipennis,* apex of female abdomen, ventral aspect.

FIG. 43. *Dikraneura variata*

C. Male genital capsule, lateral aspect (× 100).
E. Aedeagus, lateral aspect (× 100).

PLATE 15

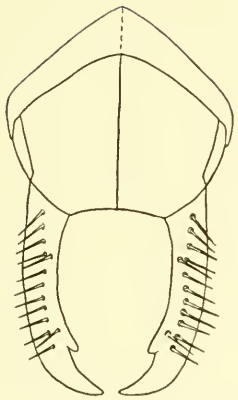
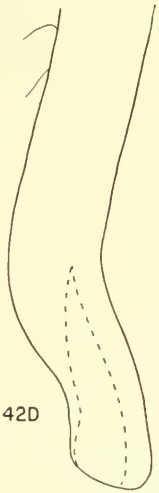
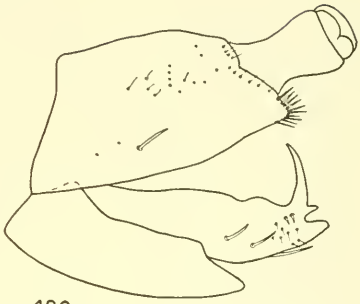


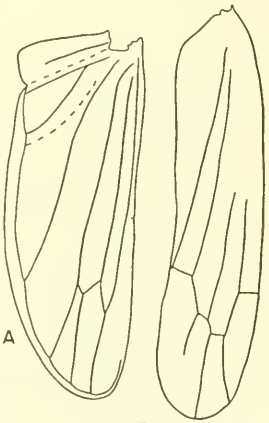
FIG. 41 DICRANONEURA LOCA



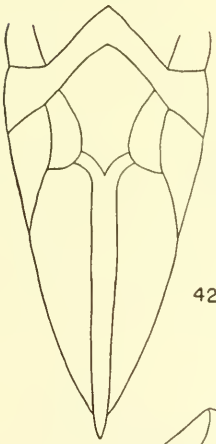
42D



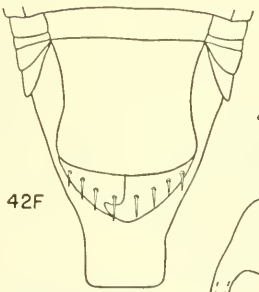
42C



42A 42B

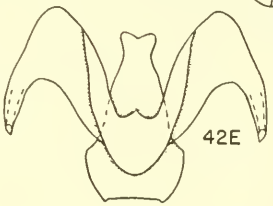


42G

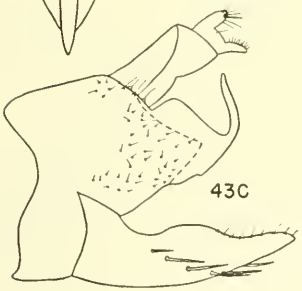


42F

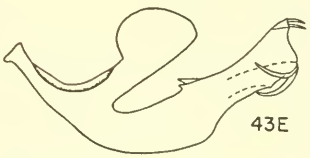
FIG. 42 NOTUS



42E



43C



43E

FIG. 43 DIKRANEURA VARIATA

PLATE 16

FIG. 44. *Dikraneura* (*Dikraneura*) *variata*
- A. Hind wing.
- B. Fore wing.
- D. Right style, broad aspect (ventral) (× 286).
- F. Connective, broad aspect (× 286).

FIG. 45. *Dikraneura* (*Delongia*) *luna*
- A. Hind wing.
- B. Fore wing.
- C. Male genital capsule, lateral aspect (× 100).

FIG. 46. *Parallaxis*
- E. *Parallaxis Donaldsoni,* aedeagus, lateral aspect (× 213) (from the holotype of *P. vacillans*).
- F. *Parallaxis* sp., fore wing.

PLATE 16

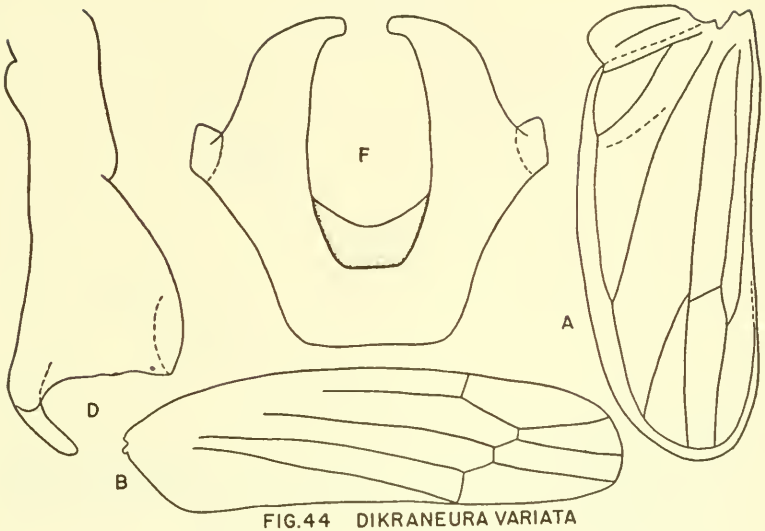


FIG. 44 DIKRANEURA VARIATA

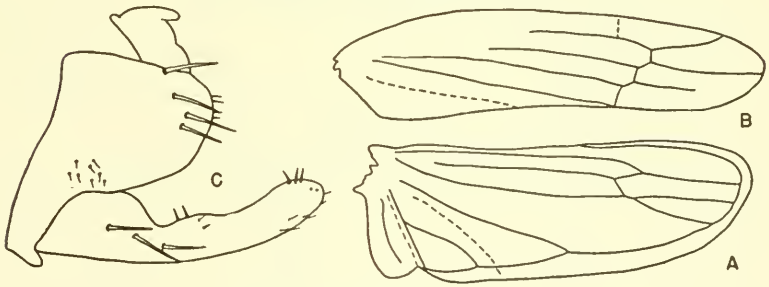


FIG. 45 DIKRANEURA LUNA

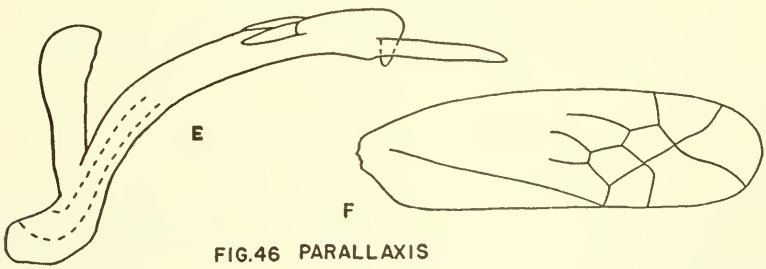


FIG. 46 PARALLAXIS

PLATE 17

FIG. 47. *Parallaxis*

A. *Parallaxis Donaldsoni,* hind wing.
B. *Parallaxis Donaldsoni,* fore wing (venation compared with type).
C. *Parallaxis* sp., male genital capsule, lateral aspect (× 100).
D. *Parallaxis* sp., right style, broad aspect (× 286).

FIG. 48. *Typhlocybella minima*

A. Hind wing.
B. Fore wing.
C. Male genital capsule, lateral aspect (× 134).
D. Right style, dorsal aspect (× 286).
E. Aedeagus, lateral and slightly ventral aspect (× 286).
F. Connective and base of aedeagus, dorsal aspect (× 286).

PLATE 17

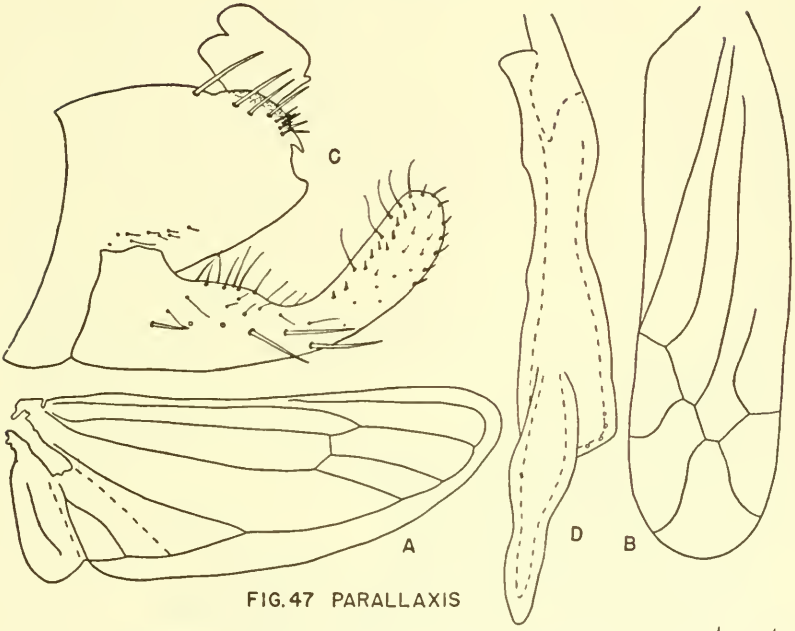


FIG. 47 PARALLAXIS

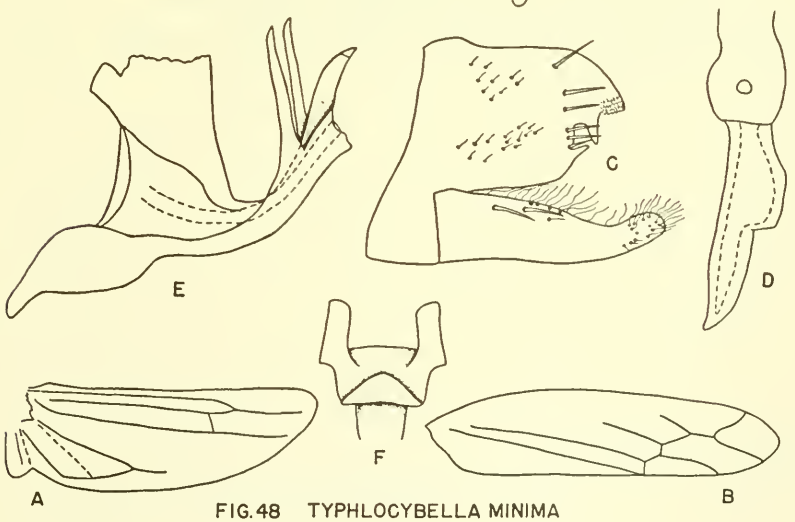


FIG. 48 TYPHLOCYBELLA MINIMA

PLATE 18

FIG. 49. *Kunzeana kunzei*
- A. Hind wing.
- B. Fore wing.
- C. Male genital capsule, lateral aspect (× 134).
- D. Right style, dorsal aspect (× 286).
- E. Aedeagus, lateral aspect (× 286).

FIG. 50. *Endoxoneura splendidula*
- B. Apex of fore wing, sketch.
- C. Type, male genital capsule, lateral aspect (× 100).
- D. Type, right style and connective, dorsal aspect (× 286).
- E. Type, aedeagus, ventrolateral aspect (× 286).

FIG. 51. *Kidrella santana,* aedeagus, ventrolateral aspect (× 286).

PLATE 18

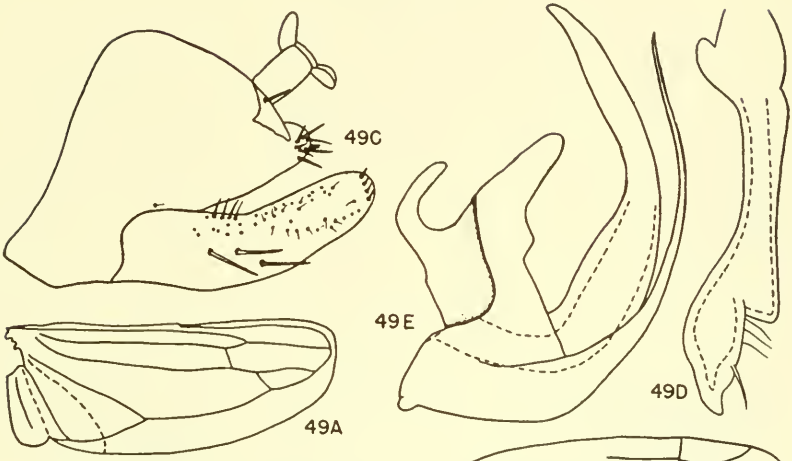


FIG. 49 KUNZEANA KUNZEI

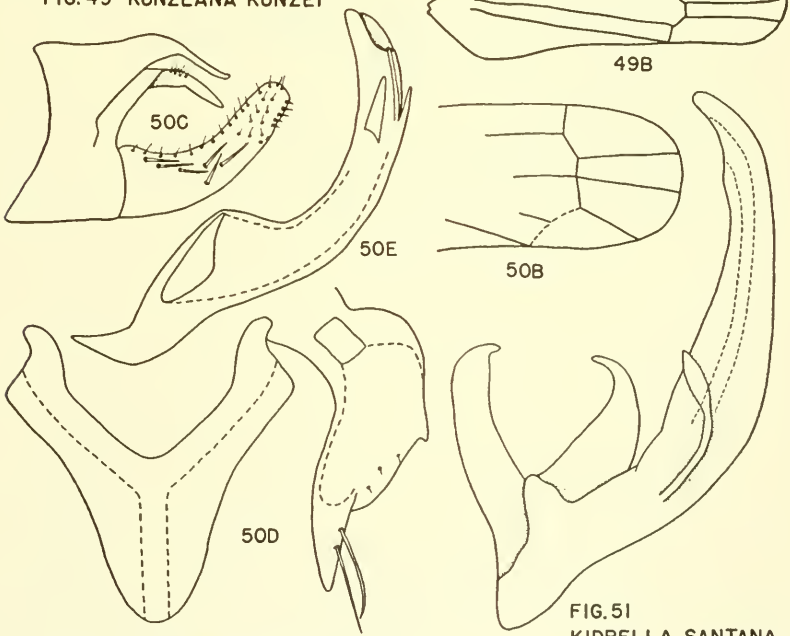


FIG. 50 ENDOXONEURA SPLENDIDULA

FIG. 51
KIDRELLA SANTANA

PLATE 19

FIG. 52. *Kidrella santana*

A. Hind wing.
B. Fore wing.
C. Male genital capsule, lateral aspect (× 100).
D. Apex of right style, broad aspect (ventral) (× 286).
F. Connective, ventral aspect (× 286).

FIG. 53. *Donidea verticis*

B. Fore wing, sketch.
C. Male genital capsule, lateral aspect (× 100).
D. Right style, near-dorsal aspect (× 286).
E. Aedeagus, ventrolateral aspect (× 286).

PLATE 19

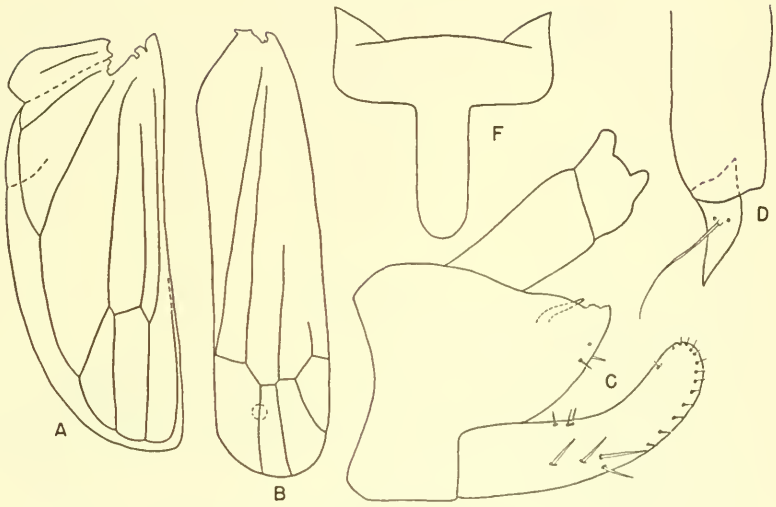


FIG.52 KIDRELLA

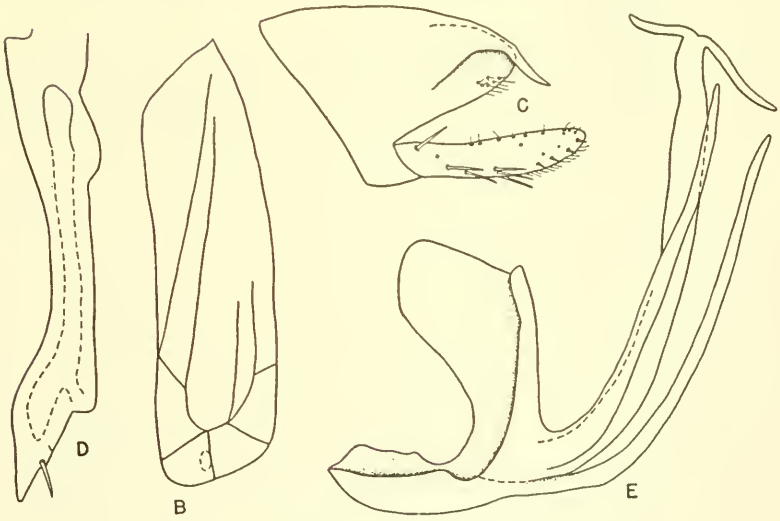


FIG.53 DONIDEA VERTICIS

PLATE 20

FIG. 54. *Alconeura* (*Alconeura*)

A. *Alconeura rotundata,* hind wing.
B. *Alconeura rotundata,* fore wing.
C. *Alconeura rotundata,* genital capsule, lateral aspect (× 100).
D. *Alconeura rotundata,* right style, ventral aspect (× 286).
F. *Alconeura dodonana,* fore wing.
G. *Alconeura santaritana,* fore wing.
H. *Alconeura unipuncta,* right style apex, ventral aspect (× 286).

FIG. 55. *Alconeura* (*Hyloidea*) *depressa*

A. Hind wing.
B. Fore wing.
D. Right style, apex, dorsal aspect (× 286).
E. Connective and aedeagus, ventral aspect, shaft turned slightly laterad (× 213).

PLATE 20

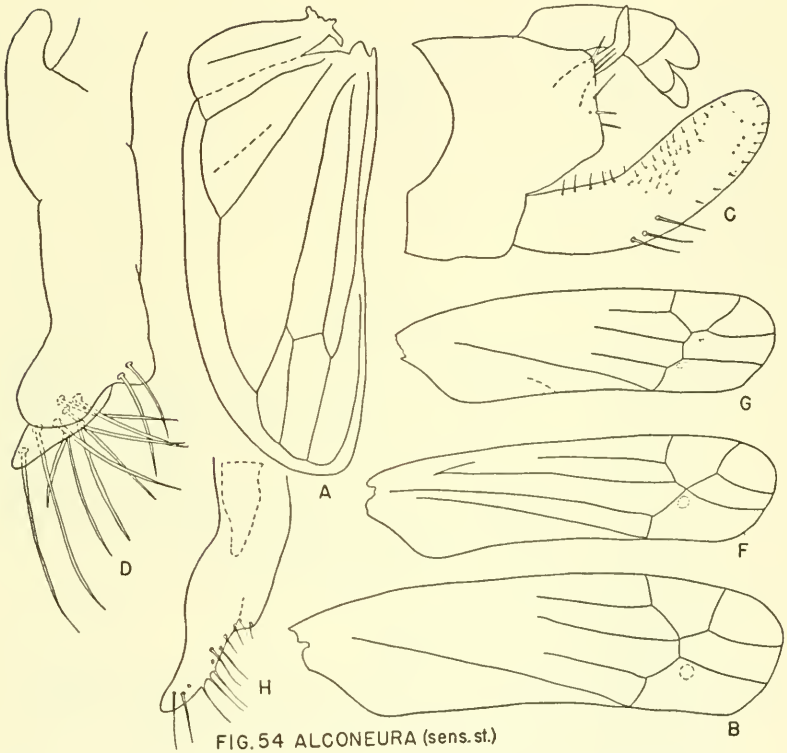


FIG. 54 ALCONEURA (sens. st.)

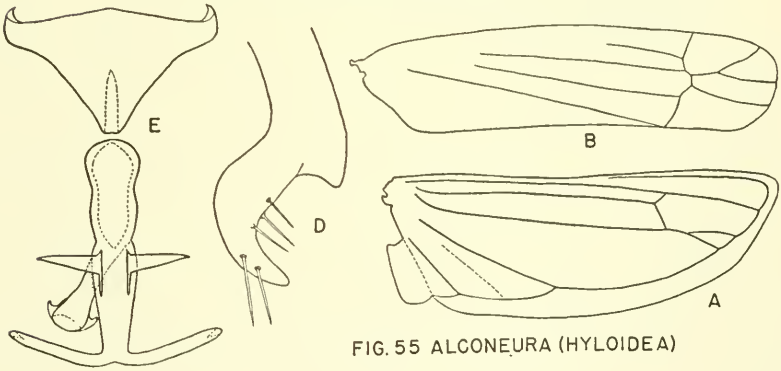


FIG. 55 ALCONEURA (HYLOIDEA)

PLATE 21

FIG. 56. *Alconeura* (*Hyloidea*)

C. *Alconeura* (*Hyloidea*) *depressa*, male genital capsule, lateral aspect (× 100).

F. *Alconeura* (*Hyloidea*) *beameri*, male genital capsule, lateral aspect (× 100).

G. *Alconeura* (*Hyloidea*) *beameri*, right style, broad aspect (× 286).

H. *Alconeura* (*Hyloidea*) *beameri*, aedeagus, lateral aspect (× 286).

I. *Alconeura* (*Hyloidea*) *beameri*, hind wing.

J. *Alconeura* (*Hyloidea*) *beameri*, fore wing.

FIG. 57. *Dikrella* (*Dikrella*)

A. *Dikrella cockerellii*, hind wing.

B. *Dikrella cockerellii*, fore wing.

C. *Dikrella cockerellii*, male genital capsule, lateral aspect (× 100).

D. *Dikrella cockerellii*, right style, broad aspect (dorsal) (× 286).

E. *Dikrella cockerellii*, aedeagus, lateral aspect (× 286).

F. *Dikrella cruentata*, fore wing.

G. *Dikrella californica* var. *imbellis*, right style, dorsal aspect (× 286).

PLATE 21

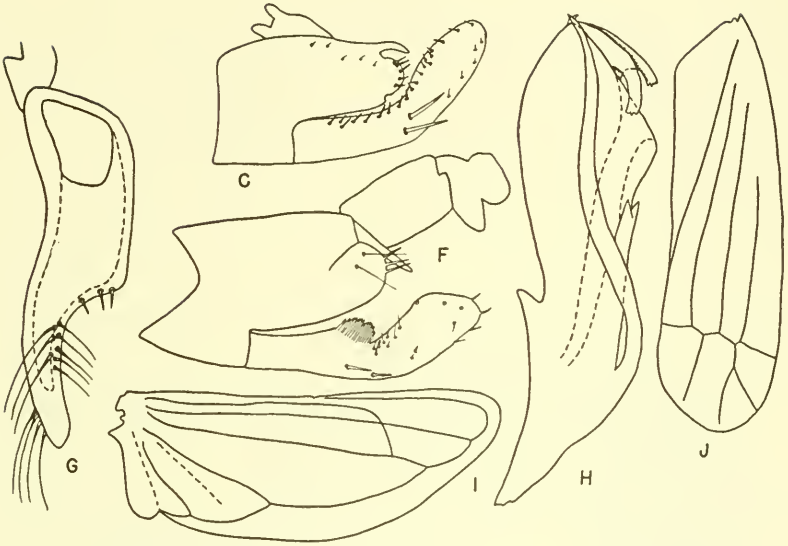


FIG. 56 ALCONEURA (HYLOIDEA)

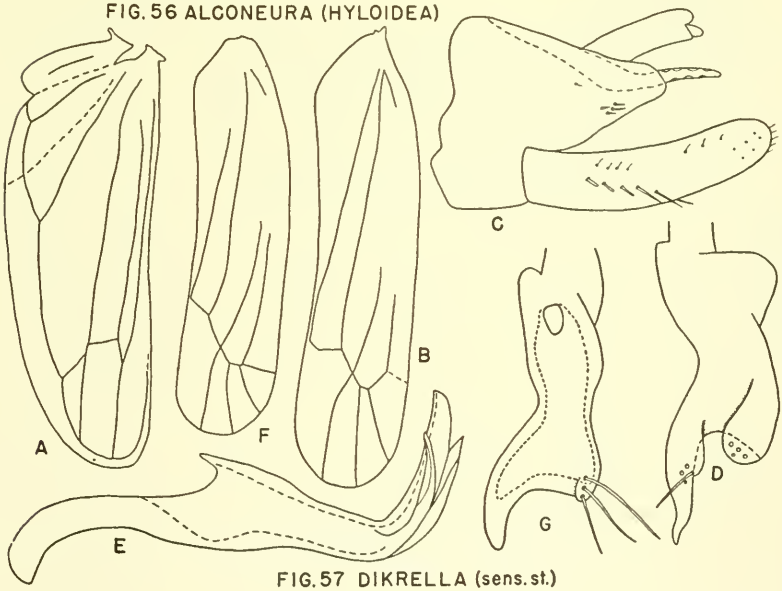


FIG. 57 DIKRELLA (sens. st.)

PLATE 22

FIG. 58. *Dikrella* (*Readionia*) *readionis*
- C. Male genital capsule, lateral aspect, anal tube not shown (× 100).
- D. Right style, broad aspect (dorsal) (× 286).
- E. Aedeagus, lateral aspect (× 286).
- F. External male genitalia, unmacerated specimen.

FIG. 59. *Idona minuenda*
- A. Hind wing.
- B. Fore wing.
- C. Male genital capsule, lateral aspect (× 100).
- D. Right style apex, dorsal aspect (× 286).
- E. Connective and aedeagus, ventral aspect (× 286).

FIG. 60. *Dikrellidia bilineata*
- C. Holotype, pygofer, lateral aspect (× 100).
- E. Holotype, aedeagus, lateral aspect (× 286).

PLATE 22

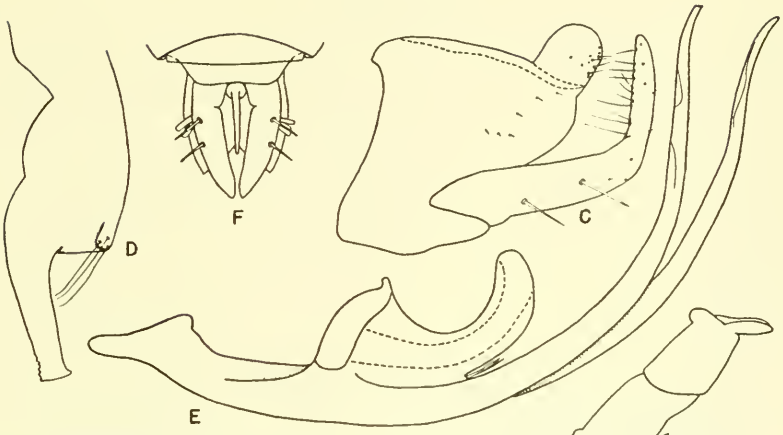


FIG. 58 DIKRELLA (READIONIA) READIONIS

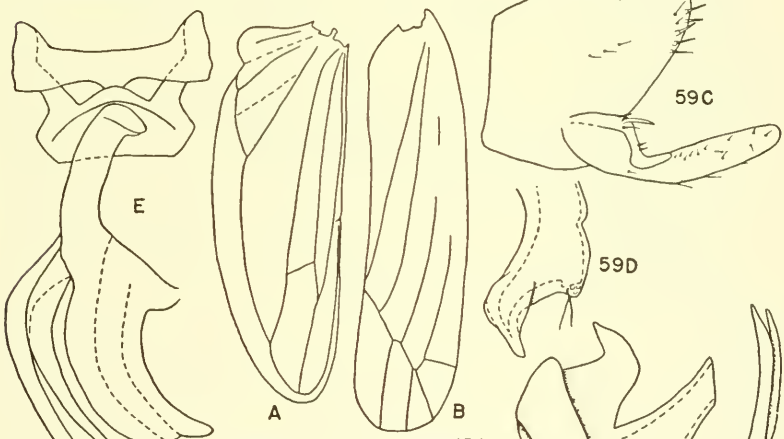


FIG. 59 IDONA MINUENDA

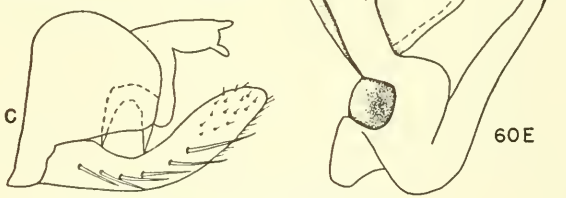


FIG. 60 DIKRELLIDIA BILINEATA

PLATE 23

FIG. 61. *Dikrellidia bilineata*
- A. Holotype, hind wing.
- B. Holotype, fore wing.

FIG. 62. *Kunzella marginella*
- A. Hind wing.
- B. Fore wing.
- C. Male genital capsule, lateral aspect (× 100).
- D. Right style, broad aspect (ventral) (× 286).
- E. Aedeagus, lateral aspect (× 286).

FIG. 63. *Neodikrella disconotata*
- A. Hind wing.
- B. Fore wing.
- E. Aedeagus, lateral aspect (× 286).

PLATE 23

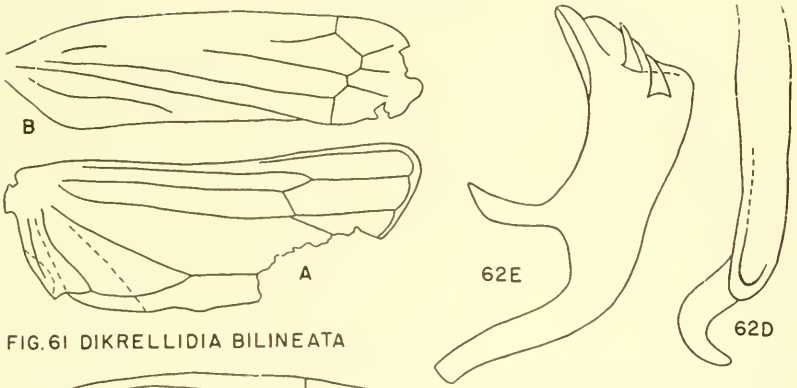


FIG. 61 DIKRELLIDIA BILINEATA

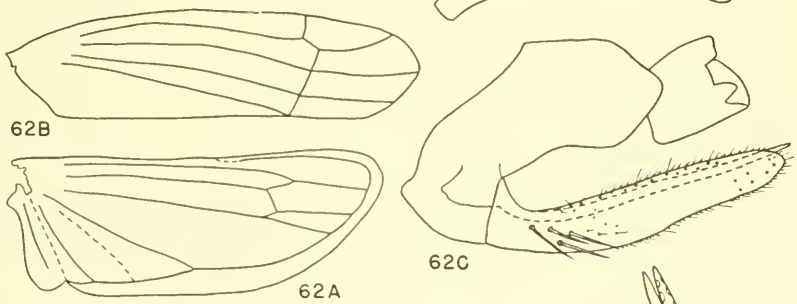


FIG. 62 KUNZELLA MARGINELLA

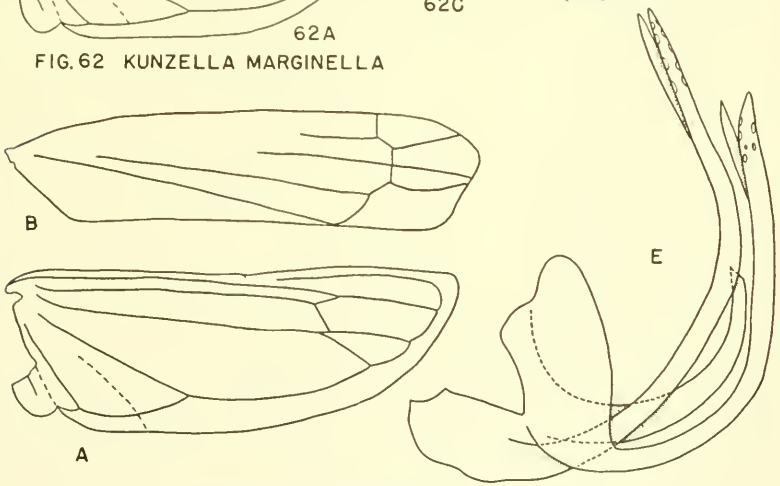


FIG. 63 NEODIKRELLA DISCONOTATA

PLATE 24

FIG. 64. *Neodikrella disconotata*

C. Male genital capsule, lateral aspect (× 100).

D. Right style and connective, dorsal aspect (× 286).

FIG. 65. *Sarascarta*

A. *Sarascarta* sp., hind wing.

B. *Sarascarta* sp., fore wing.

C. *Sarascarta fulva*, male genital capsule, lateral aspect (× 100).

D. *Sarascarta fulva*, right style and connective, dorsal aspect (× 286).

E. *Sarascarta fulva*, aedeagus, lateral aspect (× 286).

PLATE 24

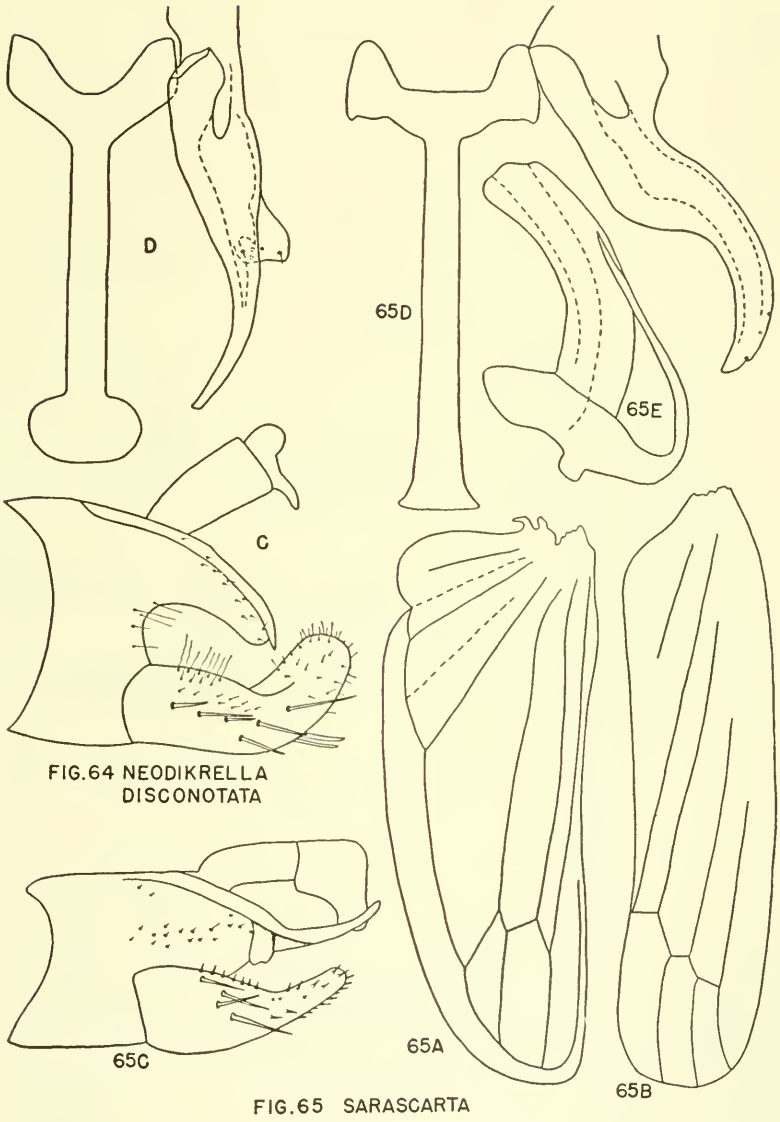


FIG. 64 NEODIKRELLA DISCONOTATA

FIG. 65 SARASCARTA

PLATE 25

FIG. 66. *Buritia lepida*

A. Holotype, hind wing.
B. Holotype, fore wing.
C. Holotype, male genital capsule, lateral aspect (× 100).
D. Holotype, right style, lateral aspect (× 134).
E. Holotype, aedeagus, lateral aspect (× 286).

FIG. 67. *Saranella micronotata*

A. Hind wing.
B. Fore wing.
C. Male genital capsule, lateral aspect, anal tube not shown (× 100).
D. Right style and connective, dorsal aspect (× 286).
E. Aedeagus, lateral and slightly ventral aspect (× 286).
G. Genital capsule, ventral aspect (× 100), small setae omitted.

PLATE 25

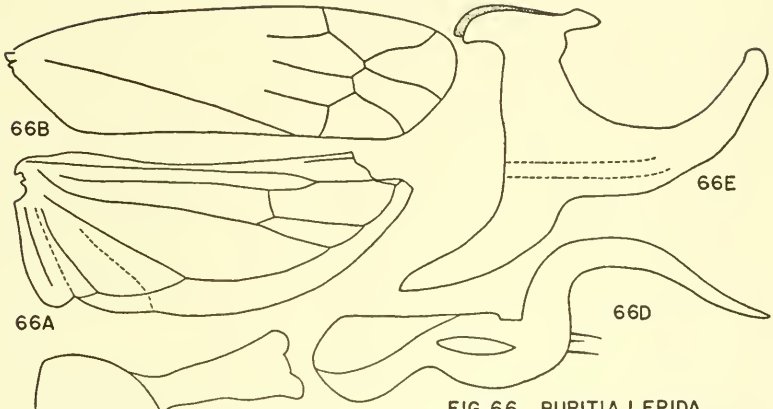


FIG. 66 BURITIA LEPIDA

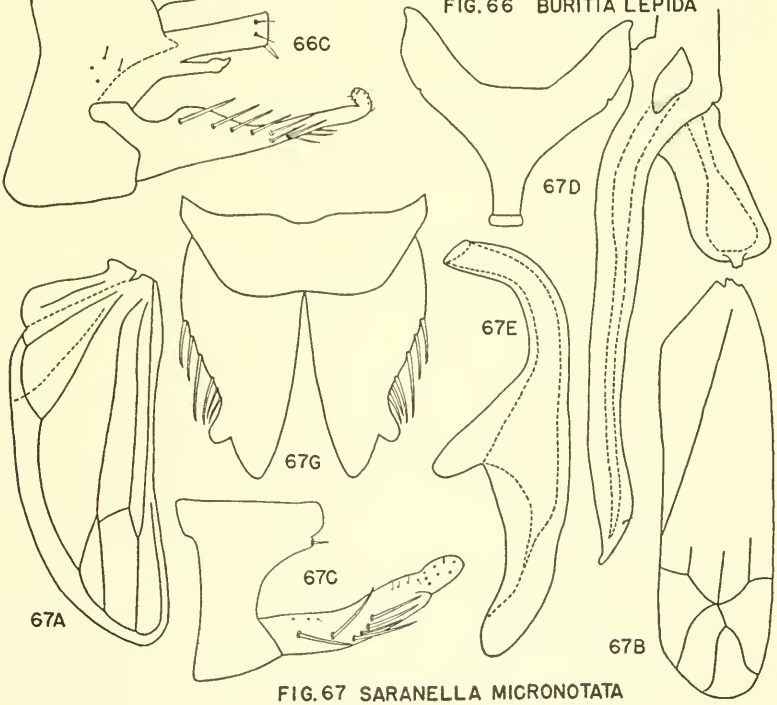


FIG. 67 SARANELLA MICRONOTATA

PLATE 26

FIG. 68. *Saranella micronotata,* genital capsule, dorsal aspect (× 100).

FIG. 69. *Hybla maculata*

A. Paratype, hind wing.
B. Paratype, fore wing.
C. Paratype, male genital capsule, lateral aspect (× 100).
D. Paratype, right style (× 286).
E. Paratype, aedeagus, lateral aspect (× 286).

FIG. 70. *Zygina nivea*

A. Hind wing.
B. Fore wing.
C. Male genital capsule, lateral aspect (× 100).
D. Aedeagus, lateral and somewhat dorsal aspect (× 286).

PLATE 26

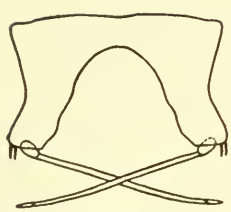


FIG. 68 SARANELLA MICRONOTATA

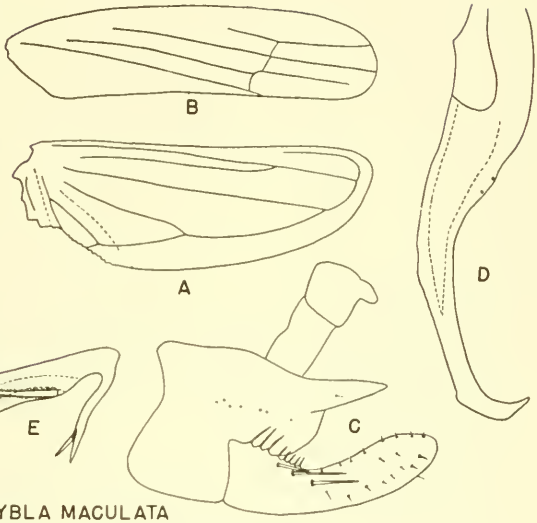


FIG. 69 HYBLA MACULATA

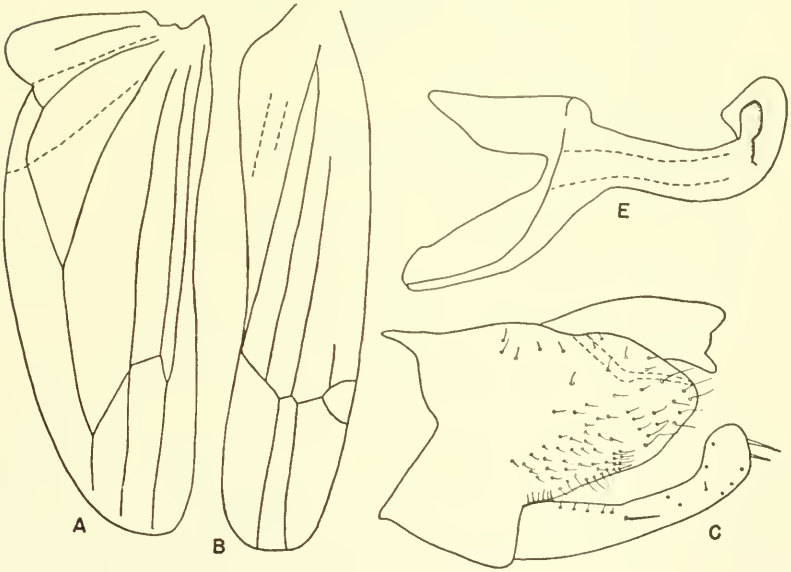


FIG. 70 ZYGINA NIVEA

PLATE 27

FIG. 71. *Zygina*

D. *Zygina nivea*, right style, mesal aspect (× 286).

F. *Zygina nivea*, connective, dorsal aspect (× 286).

G. *Zygina kiperi*, right style apex, broad aspect (× 286).

FIG. 72. *Hymetta trifasciata*

A. Hind wing.

B. Fore wing.

C. Male genital capsule, lateral aspect (× 100).

D. Right style, apical half, broad aspect (× 286).

E. Aedeagus, lateral aspect (× 286).

F. Connective, ventral aspect, showing line of attachment of aedeagus (× 286).

FIG. 73. *Erythroneura tricincta*

C. Male genital capsule, lateral aspect (× 100).

F. Pygofer, posterodorsal portion, internal aspect (× 286).

PLATE 27

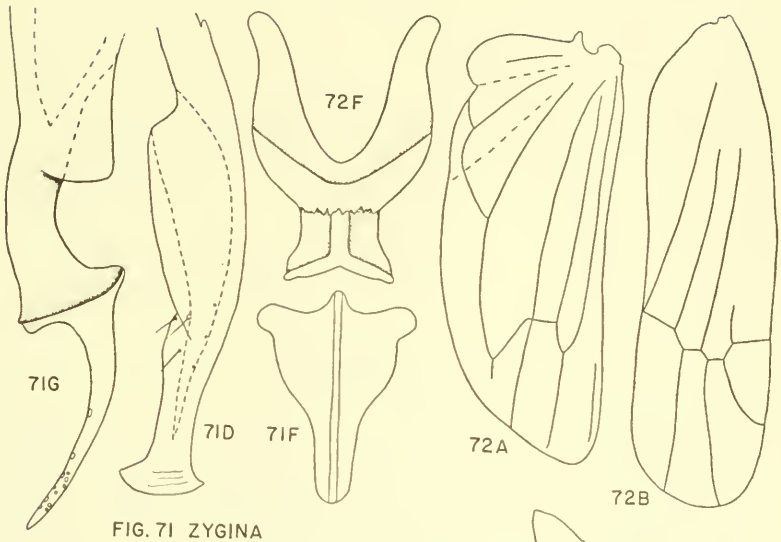


FIG. 71 ZYGINA

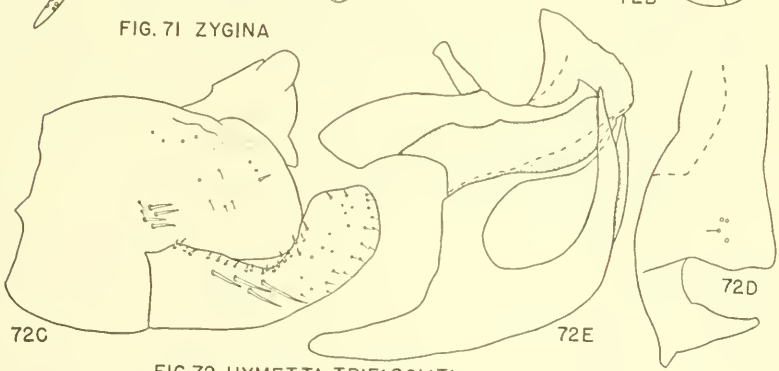


FIG. 72 HYMETTA TRIFASCIATA

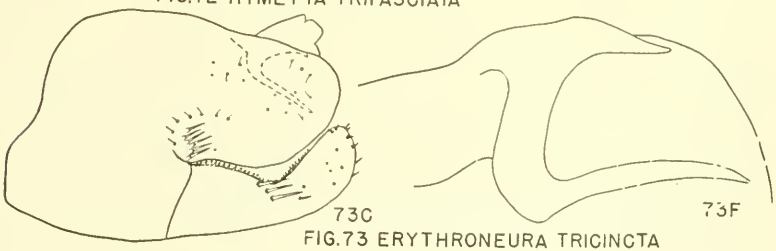


FIG. 73 ERYTHRONEURA TRICINCTA

PLATE 28

FIG. 74. *Erythroneura* (*Erythroneura*)
- A. *Erythroneura tricincta*, hind wing.
- B. *Erythroneura tricincta*, fore wing.
- D. *Erythroneura tricincta*, right style, apical half, broad aspect (× 286).
- E. *Erythroneura tricincta*, aedeagus, lateral aspect (× 286).
- G. *Erythroneura kanwakae*, pygofer process, broad aspect (× 286).

FIG. 75. *Erythroneura* (*Erasmoneura*) *vulnerata*
- B. Fore wing.
- C. Male genital capsule, lateral aspect (× 100).
- D. Right style apex, dorsal aspect (× 286).
- E. Aedeagus, dorsal aspect (× 286).

FIG. 76. *Erythroneura* (*Erythridula*) *obliqua*, fore wing.

PLATE 28

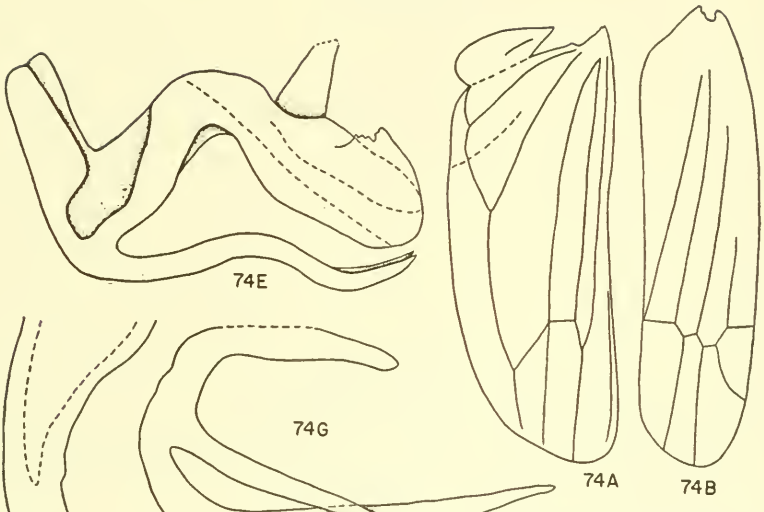
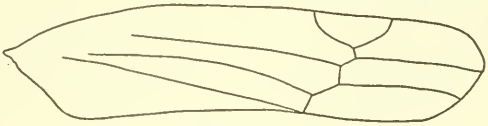


FIG. 74 ERYTHRONEURA (sens. st.)



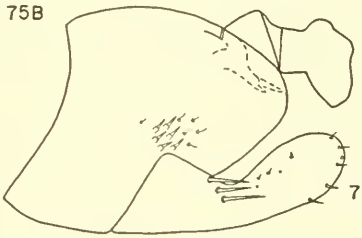
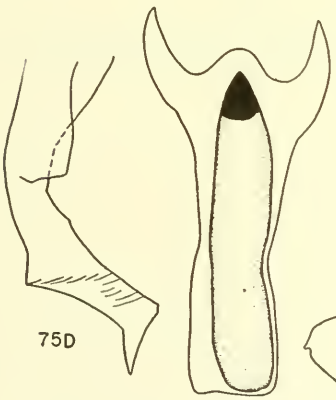


FIG. 75 ERYTHRONEURA (ERASMONEURA)



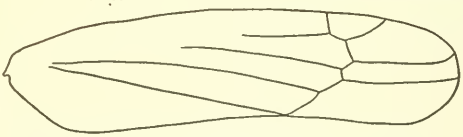


FIG. 76 ERYTHRONEURA (ERYTHRIDULA)

PLATE 29

FIG. 77. *Erythroneura* (*Erythridula*) *obliqua*

C. Male genital capsule, lateral aspect (× 100).
D. Right style apex, broad aspect (× 286).
E. Connective, ventral aspect, and aedeagus, lateral aspect (× 213).
F. Pygofer, right half, dorsal aspect (× 134).

FIG. 78. *Erythroneura* (*Eratoneura*)

B. *Erythroneura dira,* fore wing.
C. *Erythroneura dira,* holotype, male genital capsule, from balsam mount (× 100), anal tube not shown.
D. *Erythroneura dira,* holotype, right style apex, ventral aspect (× 286).
E. *Erythroneura dira,* holotype, aedeagus, lateral aspect, shaft twisted (× 286).
F. *Erythroneura nevadensis,* aedeagus, ventrolateral aspect (× 286).
G. *Erythroneura rotunda,* aedeagal shaft, lateral aspect (× 286).

PLATE 29

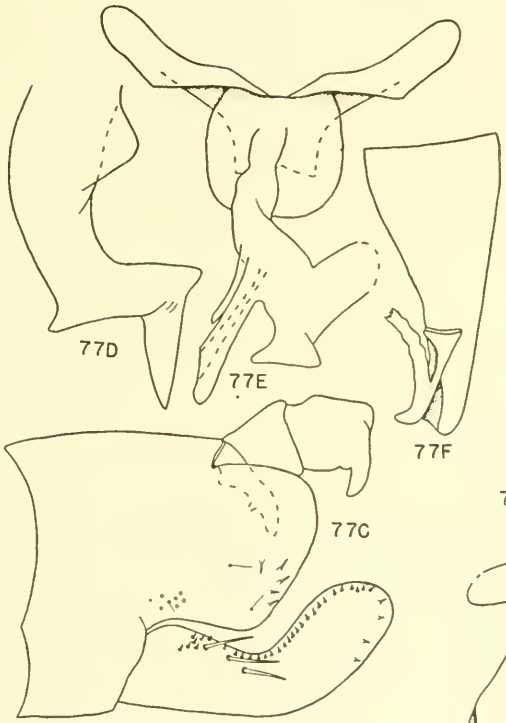
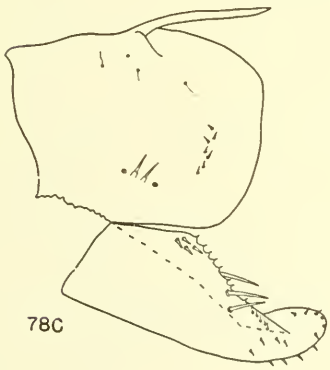


FIG. 77 ERYTHRONEURA (ERYTHRIDULA)



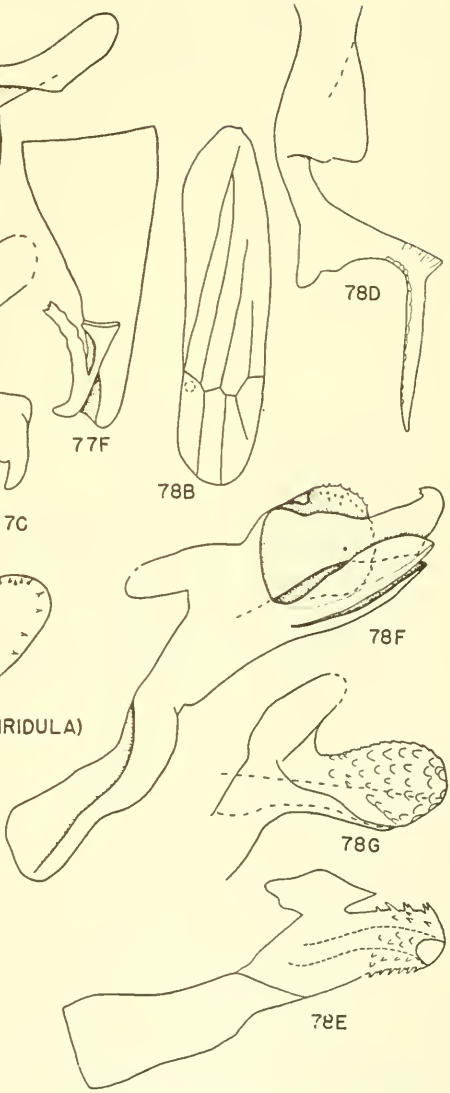


FIG. 78 ERYTHRONEURA (ERATONEURA)

PLATE 30

FIG. 79. *Eupterella mexicana*

A. Hind wing.
B. Fore wing.
C. Paratype, male genital capsule, lateral aspect (× 100).
D. Paratype, right style, broad aspect (× 286).
E. Paratype, aedeagus, left lateral aspect (× 143).

FIG. 80. *Eupteroidea stellulata*

C. Male genital capsule, lateral aspect, anal tube not shown (× 100).
D. Right style, broad aspect (× 134).
E. Aedeagus, lateral aspect (× 134).

PLATE 30

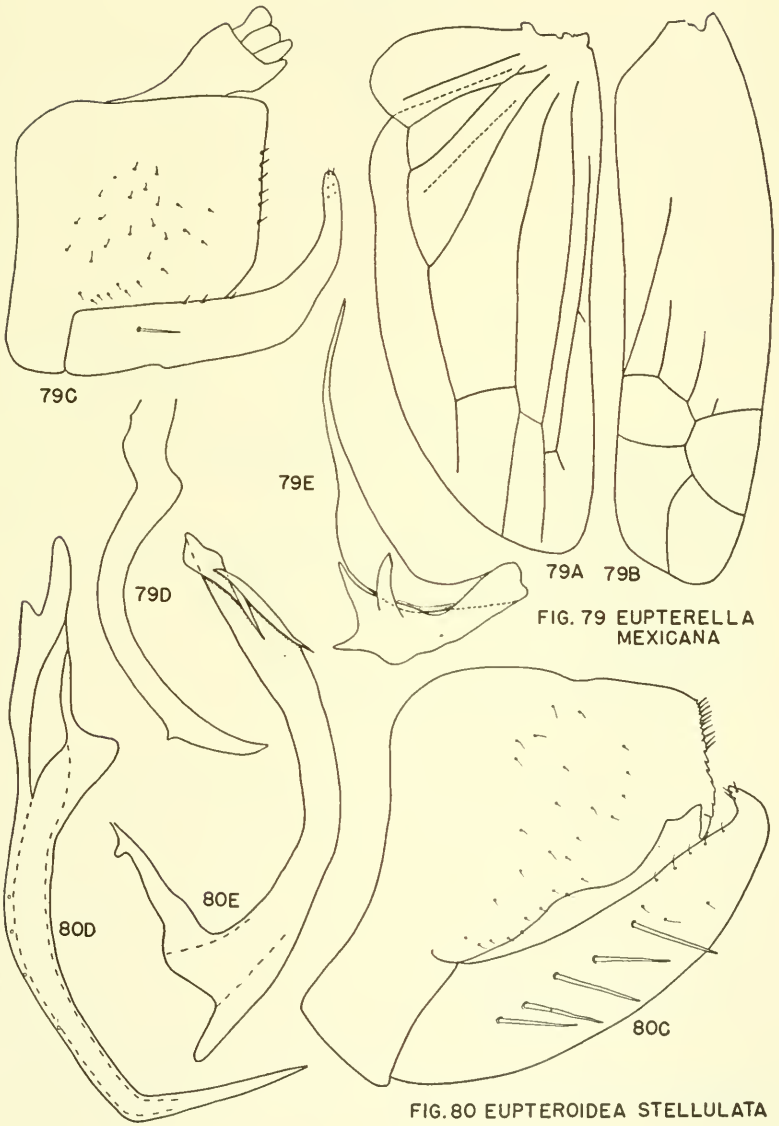


FIG. 79 EUPTERELLA MEXICANA

FIG. 80 EUPTEROIDEA STELLULATA

PLATE 31

FIG. 81. *Eupteroidea stellulata*, fore wing, apical half.
FIG. 82. *Eurhadina pulchella*
B. Fore wing, apical half.
C. Male genital capsule, lateral aspect (× 100).
D. Right style, lateral aspect, apical three fourths (× 143).
E. Aedeagus, lateral aspect (× 143).
F. Connective, dorsal aspect (× 286).
FIG. 83. *Eupteryx vittata*
B. Fore wing.
C. Male genital capsule, lateral aspect (× 100).

PLATE 31

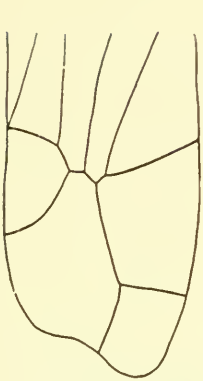
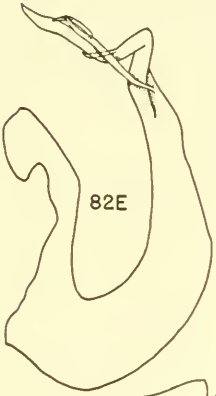
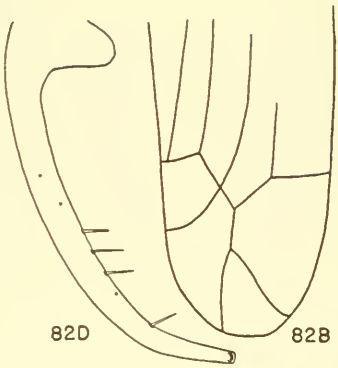
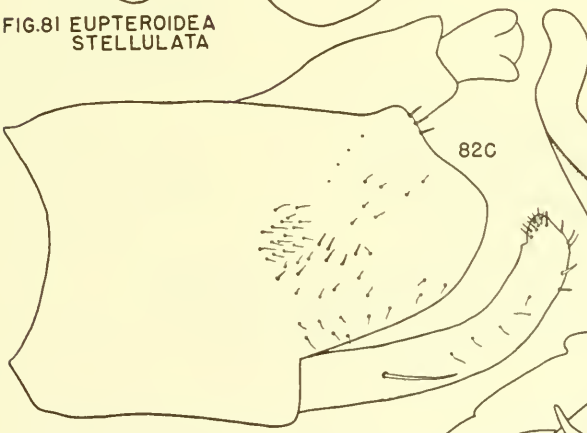


FIG.81 EUPTEROIDEA STELLULATA







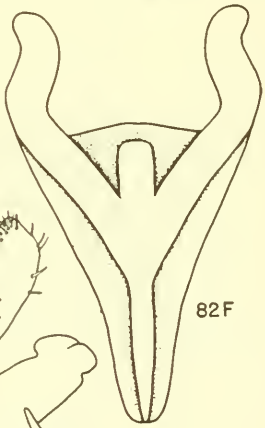
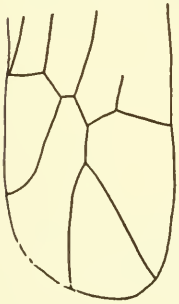


FIG.82 EURHADINA PULCHELLA



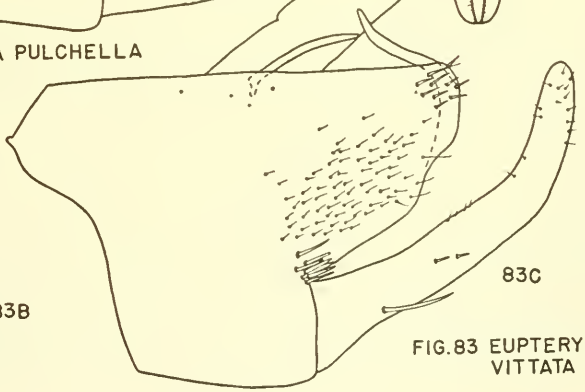


FIG.83 EUPTERYX VITTATA

PLATE 32

FIG. 84. *Eupteryx vittata*

D. Right style, broad aspect (× 286).
E. Aedeagus, lateral aspect (× 286).
F. Connective, ventral aspect (× 286).

FIG. 85. *Henribautia nigricephala*

B. Fore wing.
C. Paratype, male genital capsule, lateral aspect (× 100).
D. Paratype, right style, entire, dorsal aspect (× 286).
E. Paratype, aedeagus, lateral aspect (× 286).

PLATE 32

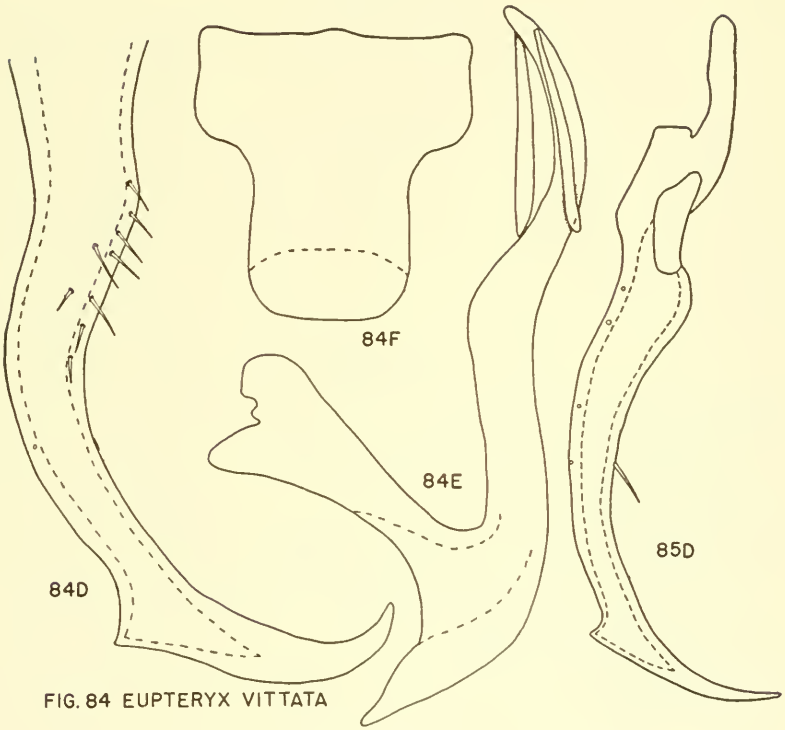


FIG. 84 EUPTERYX VITTATA

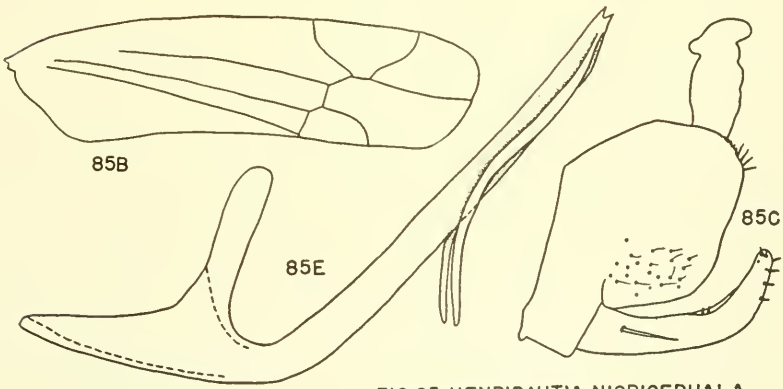


FIG. 85 HENRIBAUTIA NIGRICEPHALA

PLATE 33

FIG. 86. *Ossiannilssonia berenice*
- C. Male genital capsule, lateral aspect (× 50).
- D. Right style, broad aspect (× 134).
- E. Aedeagus, dorsal aspect (× 134).

FIG. 87. *Ribautiana ulmi*
- C. Male genital capsule, lateral aspect (× 50).
- D. Right style, apical ten thirteenths, broad aspect (× 286).
- E. Aedeagus, lateral aspect (× 213).

FIG. 88. *Typhlocyba quercus*
- A. Hind wing.
- B. Fore wing.

PLATE 33

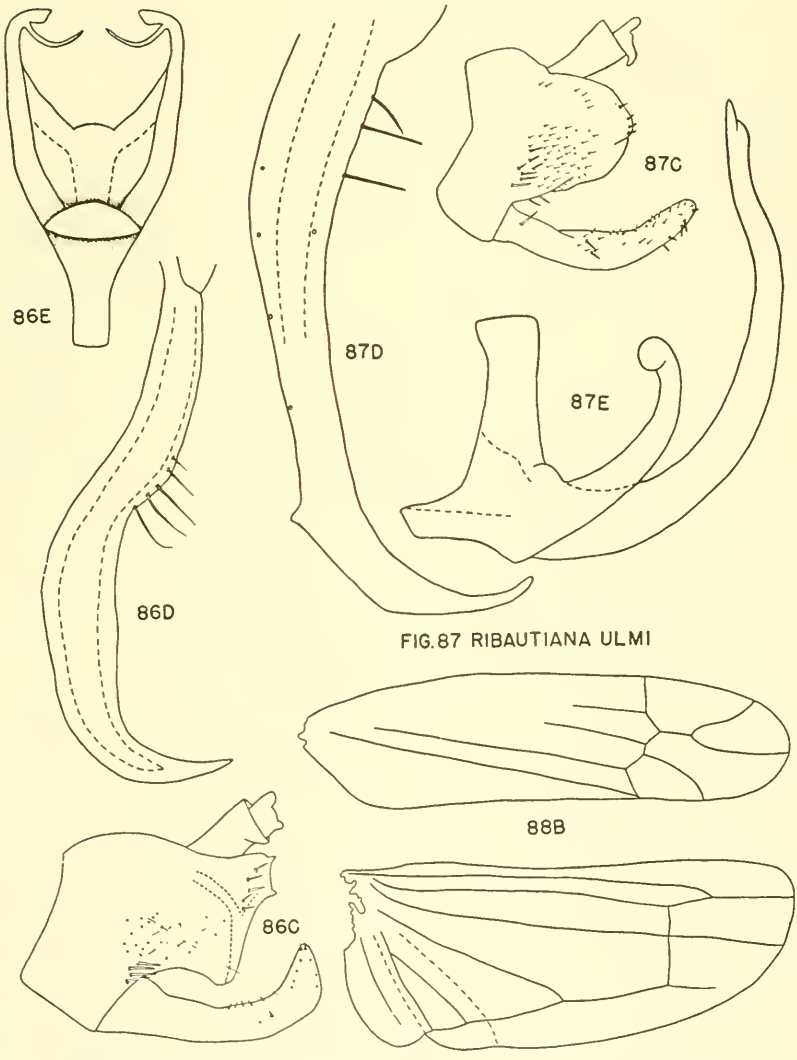


FIG. 87 RIBAUTIANA ULMI

FIG. 86 OSSIANNILSSONIA BERENICE

FIG. 88 TYPHLOCYBA QUERCUS

PLATE 34

FIG. 89. *Typhlocyba quercus*

C. Male genital capsule, lateral aspect (× 100).
D. Right style, broad aspect (× 286).
E. Aedeagus, dorsal aspect (× 134).

FIG. 90. *Eualebra smithii*

A. Holotype, hind wing.
B. Holotype, fore wing.
C. Holotype, male genital capsule, lateral aspect (× 100).
D. Holotype, right style (× 286).
E. Holotype, aedeagus, lateral aspect (× 286).

PLATE 34

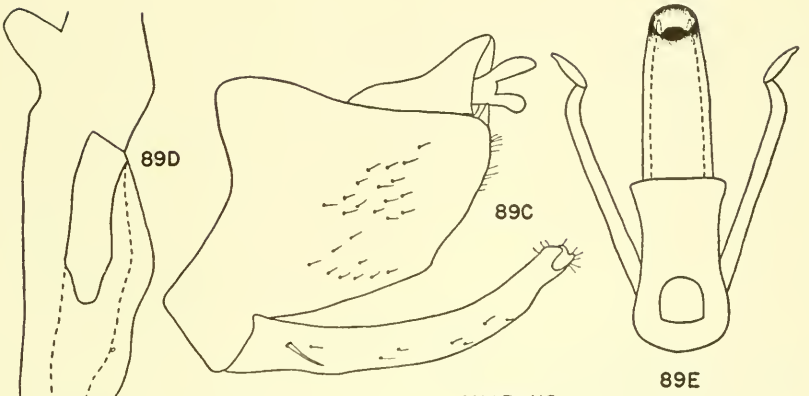


FIG. 89 TYPHLOCYBA QUERCUS

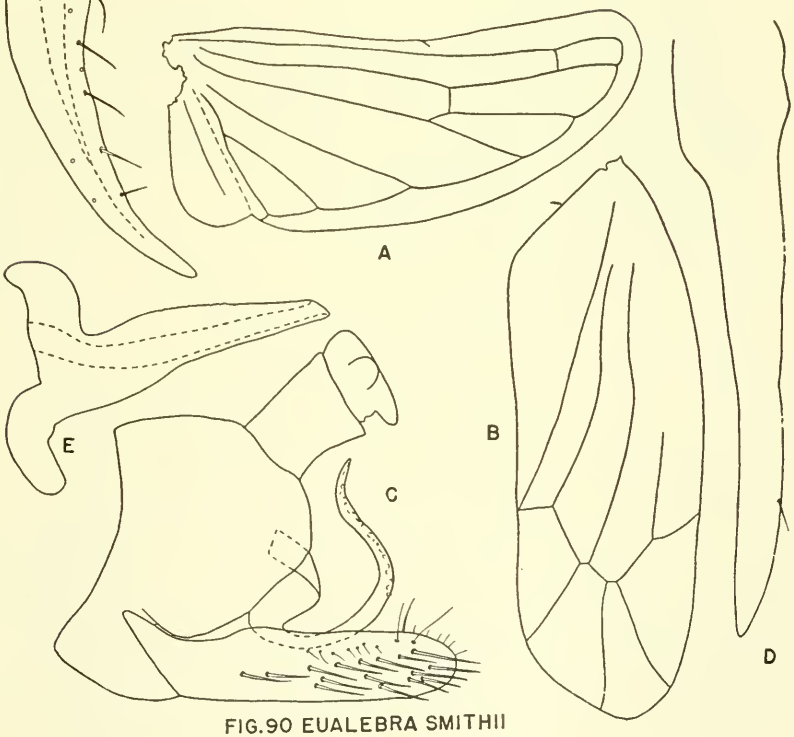


FIG. 90 EUALEBRA SMITHII

PLATE 35

FIG. 91. *Joruma* (*Joruma*) *pisca*

A. Holotype, hind wing.
B. Holotype, fore wing.
C. Allotype, male genital capsule, lateral aspect (× 100).
D. Allotype, right style and connective, dorsal aspect (× 286).
E. Allotype, aedeagus, lateral aspect (× 286).
F. Allotype, right style apex, lateral aspect (× 286).

FIG. 92. *Joruma* (*Jorumidia*) *curvata*

C. Male genital capsule, lateral aspect (× 134).
D. Right style, dorsal aspect (× 286).
E. Aedeagus, lateral aspect (× 286).

PLATE 35

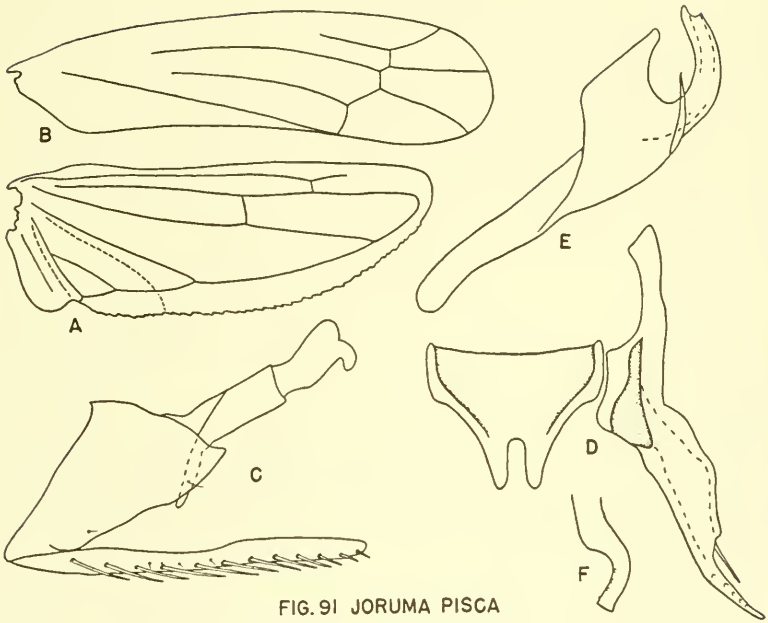


FIG. 91 JORUMA PISCA

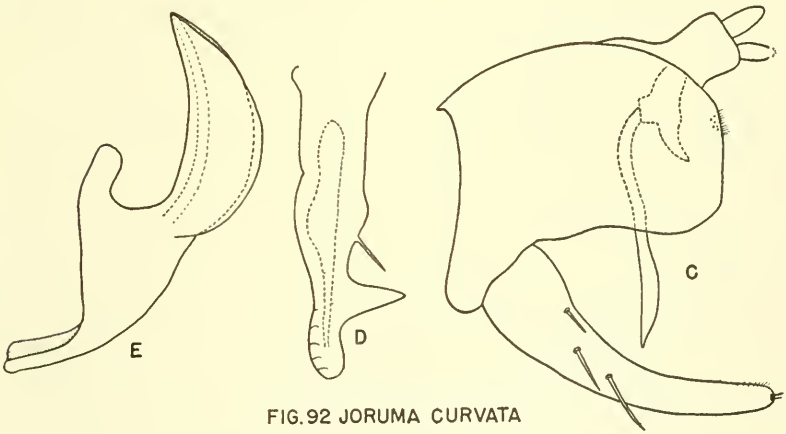


FIG. 92 JORUMA CURVATA

PLATE 36

FIG. 93. *Neojoruma adusta*

C. Holotype, male genital capsule, lateral aspect (× 67).

D. Holotype, right style, broad aspect (× 286).

E. Holotype, aedeagus, lateral and slightly dorsal aspect (× 100).

FIG. 94. *Paulomanus cecropiae*

A. Holotype, hind wing.

B. Holotype, fore wing.

E. Holotype, connective, dorsal aspect, and aedeagus, lateral aspect (× 67).

F. Paratype, right pygofer process, lateral aspect, apical third (× 286).

PLATE 36

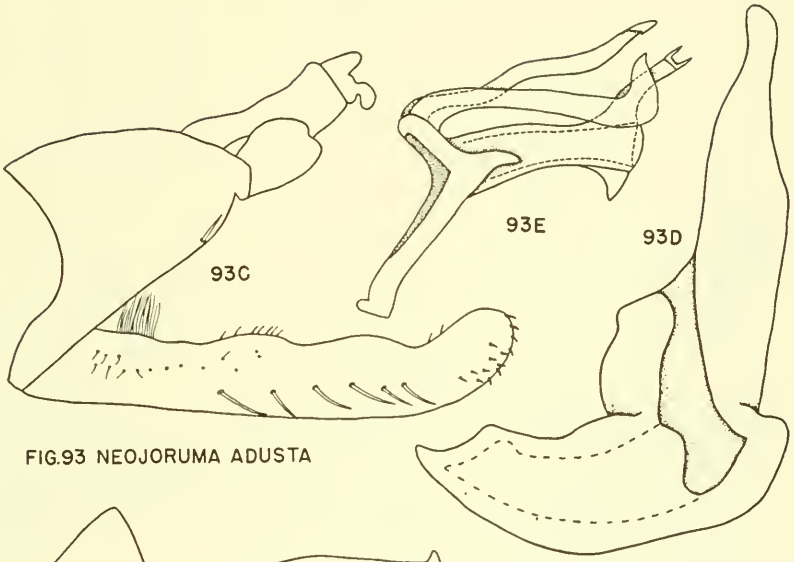


FIG. 93 NEOJORUMA ADUSTA

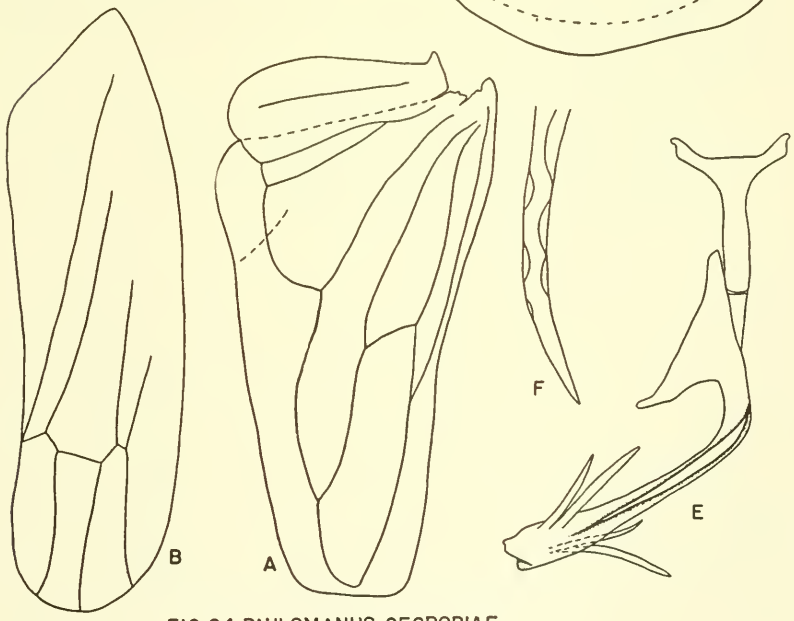


FIG. 94 PAULOMANUS CECROPIAE

PLATE 37

FIG. 95. *Paulomanus cecropiae*

C. Paratype, male genital capsule, lateral aspect (process not shown) (× 100).

D. Holotype, right style, apical two thirds, from Balsam mount, broad aspect (× 286).

FIG. 96. *Beamerana tropicalis*

A. Hind wing (from type of *Erythroneura similis,* a synonym)

B. Fore wing, from same specimen as above.

C. Allotype, male genital capsule, lateral aspect (× 67).

D. Allotype, right style, broad aspect (× 286).

E. Allotype, aedeagus, lateral aspect (× 100).

PLATE 37

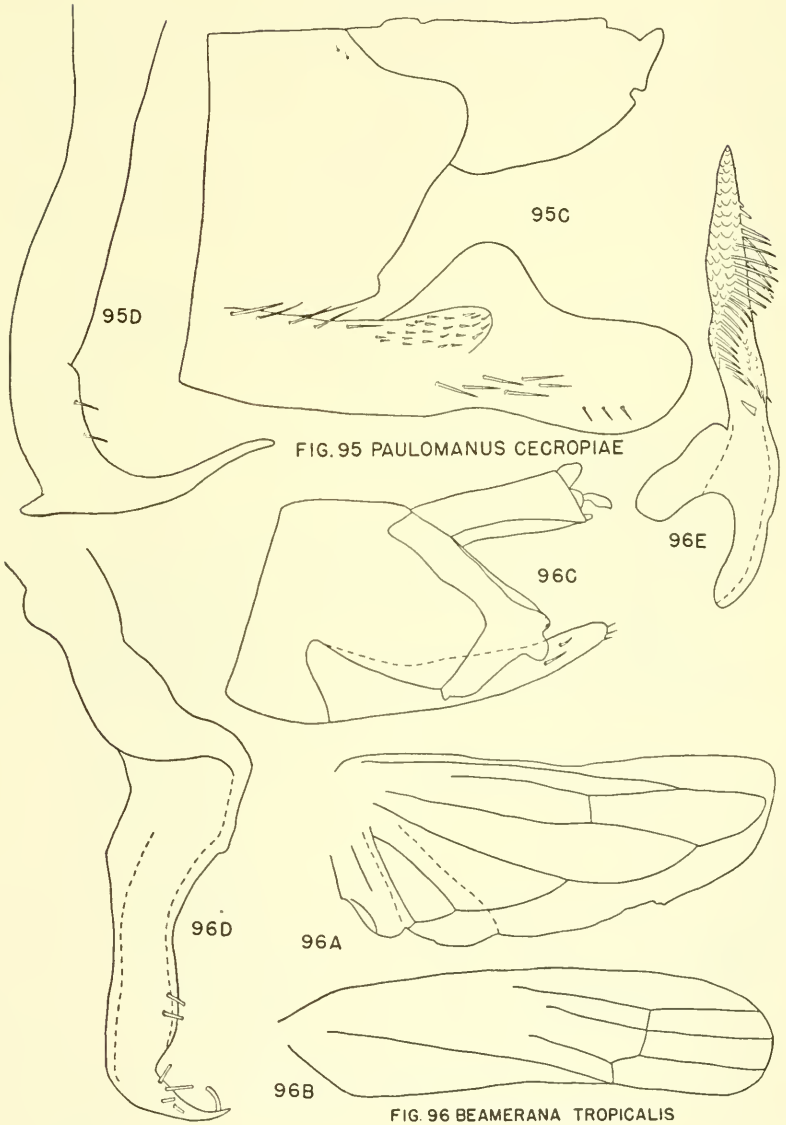


FIG. 95 PAULOMANUS CECROPIAE

FIG. 96 BEAMERANA TROPICALIS

PLATE 38

FIG. 97. *Empoasca*

A. *Empoasca fabae,* hind wing.
B. *Empoasca fabae,* fore wing.
C. *Empoasca fabae,* male genital capsule, lateral aspect (× 100).
D. *Empoasca fabae,* right style, broad aspect (ventrolateral) (× 286).
E. *Empoasca fabae,* aedeagus, anterior aspect (× 286).
F. *Empoasca fabae,* right pygofer process, broad (ventral) aspect (× 286).
G. *Empoasca confusa,* fore wing.
H. *Empoasca smaragdula,* right style apex, broad aspect (× 286).

PLATE 38

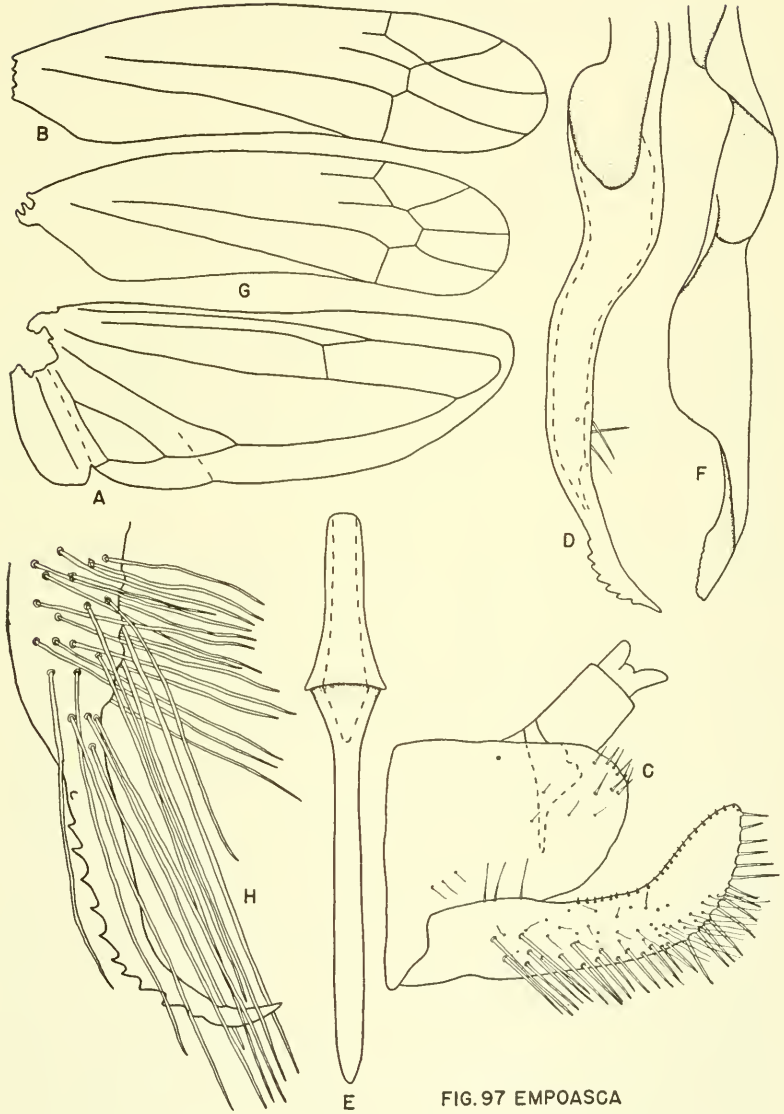


FIG. 97 EMPOASCA

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SCIENCE BULLETIN

VOL. XXXV, PT. 1] JULY 1, 1952 [NO. 2

A Revision of the Genus Osmia, Subgenus Acanthosmioides (Hymenoptera, Megachilidae)[1]

BY

JIMMY R. WHITE

ABSTRACT: This paper consists of a revision of the twenty-five species of a nearctic subgenus of bees. The subgeneric limits are considered and each species is described in detail. The synonymy indicated by previous authors has been re-examined and greatly altered. Four new species are described: *Osmia calcarata, Osmia hurdi, Osmia francisconis* and *Osmia obliqua.*

INTRODUCTION

This paper is a systematic revision of the bees of the subgenus *Acanthosmioides* Ashmead, of the genus *Osmia.* The name was proposed by Ashmead (1899) as a genus for the single species, *Osmia odontogaster* Cockerell, in a key to the genera of bees.

The subgenus *Acanthosmioides* is restricted to the Nearctic region and is one of six subgenera of *Osmia* occurring in the Western Hemisphere. A key to these subgenera was presented by Sandhouse (1939). Since the time of Ashmead's recognition of the group, several workers have described species and discussed the group, but Sandhouse presented the first systematic treatment of these bees as a subgenus. The early workers relied too much on body and hair color in describing species of *Osmia.* Structural characteristics for separation of the species are numerous but often subtile; therefore a rather extensive description of each species, using a combination of all possible characteristics, has been needed for some time. In many instances it has been possible to study long series of particular species and in this case one can find certain hair color characteristics which hold true throughout the range of the species. Sandhouse described briefly, but not con-

1. Contribution no. 770 from the Department of Entomology of the University of Kansas.

sistently, the metasomal sterna of the males. In the present paper these plates are described in detail, and it appears possible to separate the males by the characters found on the second and fourth sterna alone if necessary. The males of few species present a problem in determination, but taxonomic difficulties among the females are numerous. Females are very similar structurally, and it has been necessary to utilize all characters in order to separate them. The mandibular teeth and the punctation of the metasomal terga afford the best characters.

Most of these bees are early spring forms and have not been thoroughly collected. Relatively little is known of the time or place of mating and this fact plus the lack of structural similarity between the sexes of most species has made it virtually impossible to match the sexes except by using locality, date and flower records.

Of the twenty-five species here included in *Acanthosmioides* all have been available to me except two. The descriptions of *O. watsoni* and *ashmeadii* are based upon the descriptions of Sandhouse (1939) supplemented by notes on the types kindly provided by Mr. Karl V. Krombein. Four of the species are new and four new correlations of males and females have been made.

The morphological terms used herein have been taken from Michener (1944). The names "velum" and "malus", used in describing the strigilis, are from Rayment (1935). Velum refers to the thin membranous portion and malus to the thicker lower surface which is usually produced apically.

Since the metasomal sterna of the males contain excellent characters, they have been removed from certain specimens of each species, along with the trophi and genital capsules. These structures were boiled for two minutes or less in potassium hydroxide, washed in weak acetic acid, and placed in glycerine in small vials. These bottles are placed, at an angle, on the pin by pinning through the cork. This enables the worker to view the preparations from any angle, after he has removed structures from the vial and placed them on a slide in glycerine.

I wish to thank Dr. C. D. Michener for suggesting this work and for his advice and direction in the preparation of this paper. Much of the material studied was from Doctor Michener's private collection which is now in the Francis Huntington Snow Museum at the University of Kansas. I am thankful for the loan of material from the United States National Museum, the American Museum of Natural History, the University of California, the California Academy of Sciences, the Canadian National Collection, Utah State

College, and the private collection of Dr. G. E. Bohart. Mr. Karl V. Krombein and Dr. E. S. Ross were most helpful in comparing specimens with the types under their care. I wish also to thank Prof. P. H. Timberlake for certain helpful suggestions.

EXCLUDED SPECIES

Sandhouse included in her revision (1939) several species which, it seems, do not agree closely enough with the characters of *Acanthosmioides* to warrant leaving them in the subgenus.

O. hendersoni has a rather broad head which is not typical of *Acanthosmioides*. The mandibles are broad and thick, not slender, and the constrictions are never less than one and three-fourths times as wide as the apices. Probably the most distinctive characteristics of the species are the largely black body color and the very wide, apical, impunctate, shining bands of the metasomal terga. None of these characters agrees with *Acanthosmioides*. *O. kenoyeri* has probably been placed in *Acanthosmioides* in the past because of the midapical tumescence on the second metasomal sternum of the male. If this species is compared with *O.* (*Melanosmia*) *bucephala*, one sees that they are closely allied because in both species the abdomen is wider posteriorly than anteriorly, the fore and middle tarsi are greatly modified, the hind femora are modified with apical semicircular emarginations and toothlike projections, the fifth and sixth metasomal terga have rather broad, apical folds, and the second metasomal sterna are apically tumescent. Of these characters, only the tumescence of the second sternum agrees with *Acanthosmioides*. In my opinion both of the above mentioned species (*hendersoni, kenoyeri*) should be placed in *Melanosmia*, and both are excluded from *Acanthosmioides* in this paper.

The mandible of *O. melanopleura* is too wide at the constriction to warrant placing this species in *Acanthosmioides*. As has been stated many times, the females of *Acanthosmioides* and of *Nothosmia* are hard to distinguish. Since the females of *Acanthosmioides* have been recognized by the mandibular constriction which is one half as wide as the apical width of the mandible, this species has been removed to *Nothosmia*.

Sandhouse associated males and females in *O. enixa*. The females have been identified as *Acanthosmioides* and described as new (*francisconis*). The males have typical *Nothosmia* mandibles, with the two teeth very similar and separated by a wide, V-shaped notch. There is a complete absence of any modification on the second metasomal sternum and the proess of the gonocoxite arises from

the apex of the gonocoxite. Therefore, the true *O. enixa,* based on a male, is placed in *Nothosmia.*

SUBGENERIC CHARACTERISTICS

Previous workers have included in *Acanthosmioides* certain species here placed elsewhere. *O. hendersoni, kenoyeri, melanopleura,* and *enixa* (male) do not seem to belong in the subgenus for reasons discussed under the heading "Excluded Species." There remain three groups into which species of *Acanthosmioides* fall. The true *Acanthosmioides* is represented by the following species: *lanei, giffardi, ashmeadii, watsoni, obliqua, nigrobarbata, calcarata, sladeni, unca, odontogaster, physariae, nifoata, scdula, trifoliama, francisconis, nigrifrons, hurdi, dakotensis* and *giliarum.* These species are the only ones considered in the following subgeneric description. As was explained in the introduction, distinguishing characters are hard to find in the females and subgeneric characters are even more scarce. The only good subgeneric character is found by comparing the width of the apex of the mandible with the width of the constriction near the base. The mandible of *Acanthosmioides* is one half as wide at the constriction as at the gradually widened apex. Five desert species (*prunorum, titusi, lupinicola, liogastra* and *morongana*) form a group of which no males are yet known but which has the mandibles of *Acanthosmioides.* These females differ markedly from *Acanthosmioides* proper in the predominance of white hairs, including even a white scopa in *prunorum, titusi,* and *lupinicola. O. morongana* has almost as much dark hair as light, but is known only from the desert region near Morongo, California.

Further study may prove *longula* and *integra* to be members of *Melanosmia.* The male of *longula* has a needlelike or keellike apical projection on both the first and second metasomal sterna. None of the other males of the subgenus have such projections and only a few show any projection on the first metasomal sternum. The greatly enlarged and distorted tarsal segments and the middle coxal spines are found in some members of *Melanosmia* but not in any other *Acanthosmioides.* Males of *integra* have no trace of a projection on the second metasomal sternum, the fourth does not have "hooked" bristles and its apex is not modified, the sixth and eighth are entirely different from other members of the subgenus. The female mandibles of both of these species are like those of *Acanthosmioides,* for which reason they are tentatively retained in the subgenus. In *integra* the mandible is not as gradually widened from

the constriction to the apex but in *longula* one is hard pressed to find differences from the mandibular characteristics of the true *Acanthosmioides.*

SUBGENERIC DESCRIPTION

Male: Length of body, 6 to 14 mm.; of fore wing, 5 to 9 mm. Mandible with V-shaped notch separating long, slender, lower tooth from truncate or oblique upper tooth; carinae moderately raised (upper carina in *nigrobarbata* greatly raised); mandible slender, constructed just distad of base, gradually widened to apex which is usually twice as wide as width of constriction. Trophi: First and second segments of labial palpus usually subequal; third segment of maxillary palpus longest of the five segments, usually subequal in length to combined lengths of four and five. Clypeus from weakly to strongly convex, thickly covered with erect, white hairs arising from fine, contiguous punctures; apex subtruncate with a narrow, thickened, impunctate margin. Punctations on head and thorax dense and rather deep; on abdomen sparse and shallow. Head broader than long. Paraocular carinae nearly parallel, converging but little below. Posterior margin of vertex slightly concave. Scape about five times longer than pedicel; flagellar segments 2 to 11 subequal in length and width. Hypostomal carina never greatly produced, usually low and gradually raised from posterior end to angle. Segments of fore tarsus rather weakly swollen, but more strongly so in some species than in others; middle tarsal segments longer than wide; mediotarsi and disitarsus of hind leg longer than wide; posterior surface of hind tibia flat, covered with short, fine, tawny pubescence. Cells of wings with short hairs, apex of fore wing papillate; vein M interstitial with or only slightly basad of vein cu-v. Metasomal terga two to five with apical impunctate bands; apical margin of six turned up forming a weak flange; apex of seven produced, the mid-apex of production emarginate, forming two teeth. Ventral surface of second metasomal sternum with a median-apical production (usually a projection), on each side of which the apical margin is fringed with long hairs; third with a shallow median-apical emargination which is thickly fringed submarginally with long hairs; fourth with a median apical patch of bristlelike hairs bent mesad at tips, surrounding an impunctate portion of varying shapes, lateral patches of thinner, straight hairs; fifth with a mid-apical, almost semicircular emargination of varying depths; sixth with a median apical produced portion the apex of which is either truncate or slightly emarginate

(usually with lateral, divergent teeth); eighth greatly reduced, its apical half either triangular or produced into a subrectangular process. Gonocoxite with a process arising before its apex, apical half of process usually spatulate.

Female: Length of body, 6 to 12½ mm.; of fore wing, 4 to 9 mm. Mandible tridentate, upper tooth either triangular or with lower truncation, lower tooth longest; mandibular carinae parallel, moderately raised; mandible slender, constricted just distad of base, gradually widened to apex, which is twice as wide as width of constriction. Trophi as in male. Clypeus convex except in *trifoliama* where it is flat, punctures coarser than in male, giving rise to rather sparse, coarse hairs (not necessarily erect); apex subtruncate, with a wide, unthickened, impunctate band (not extending laterally in some species). Punctations on head and thorax coarse and dense, any spaces between punctures smooth; on abdomen sparser, finer, and shallow. Head very nearly same shape as in males, genal areas more hidden behind eyes. Paraocular carinae nearly parallel, converging even less than in males. Posterior margin of vertex concave. Scape five times longer than pedicel; first flagellar segment longer than second, segments gradually lengthened and widened from second to tenth. Hypostomal carina never greatly produced, usually higher than in males, highest at angle and more rapidly reduced posteriorly than in males. Mediotarsal segments of foreleg swollen, width subequal to length, hairs on upper surface of basitarsus longer than combined lengths of remaining segments; middle and hind tarsal segments longer than wide; hind basitarsus only slightly wider just before base than elsewhere, apex rounded. Hind tibial spurs slender. Wings as in male, but usually hairs in cells denser. Metasomal terga two to five with apical impunctate bands (scattered punctures extend to apical margin in *sedula*); six with apical third forming a flange.

KEY TO THE SPECIES

1. Males[2] 2
   Females 13
2. Apical edge of mandible, above long lower tooth, strongly oblique; superior apical angle obtuse 3
   Apical edge of mandible above long lower tooth transverse (truncate) or if oblique, only slightly so; superior apical angle acute (seldom a right angle) 9

2. Since the author has not seen specimens of *ashmeadii* (Titus) and *watsoni* Cockerell, they have been omitted from this key. However, the flattened apical segment of the flagellum of both suggests *lanei* and *giffardi*. *O. watsoni* has no apical projection on the second metasomal sternum (but has a tumescence), and *ashmeadii* has the first metasomal sternum carinate on the ventral surface.

3. Mediotarsal segments of middle leg swollen as much as or more than those of fore tarsus, as wide as or wider than long; apical segment of flagellum flattened, its inner margin produced, making it one fourth wider at its widest portion than preceding segments 4

Mediotarsal segments of middle leg not swollen, longer than wide; apical segment of flagellum as wide as preceding segments 6

4. Mid-apex of first metasomal sternum with a spinelike projection extending well beyond apical margin of sternum; antero-apex of middle basitarsus produced; middle coxa with a projection on postero-median angle ..... *longula*

Mid-apex of first metasomal sternum with a shallow, narrow notch, the margin on each side of which is slightly produced; middle basitarsus without projection on apex; middle coxa unmodified 5

5. Mid-apical projection of second metasomal sternum with its apex, in ventral view, at least one half as wide as width of hind basitarsus medially; process of gonocoxite slender, its apical third very little if any enlarged ..... *lanei*

Mid-apical projection of second metasomal sternum with its apex, in ventral view, no more than one third as wide as width of hind basitarsus medially; process of gonocoxite shorter, its apical one third greatly widened (spatulate) ..... *giffardi*

6. Inferior apical angle of hind basitarsus produced, forming an acute angle; pubescence mostly white. (Inner hind tibial spur more than two thirds as long as hind basitarsus) *obliqua*

Inferior apical angle of hind basitarsus not produced, either a right angle or rounded; pubescence usually nearly as much black as white (some specimens of *nigrobarbata* with more white) 7

7. Second metasomal sternum with a mid-apical, uncinate process; upper apex of mandible so strongly oblique that superior apical angle is absent or very nearly so; fourth metasomal sternum with a thin, rather long, sharp, mid-apical projection ..... *nigrobarbata*

Mid-apical projection of second metasomal sternum laterally compressed or digitiform, not uncinate; superior apical angle of mandible always present and obtuse; apical margin of fourth metasomal sternum truncate or rounded 8

8. Mid-apical projection of second metasomal sternum digitiform, same width dorsoventrally as thickness of sternum; mid-ventral groove (narrow) extending from apex of process across surface of sternum; inner hind tibial spur abruptly bent in middle ..... *calcarata*

Mid-apical projection of second metasomal sternum laterally compressed, spatulalike, much wider dorsoventrally than sternum; ventral surface of process narrow, rounded; inner hind tibial spur not bent in middle ..... *sladeni*

9. Mid-apical projection of second metasomal sternum uncinate (not so strongly as in *nigrobarbata*); fourth metasomal sternum with a slender, sharp mid-apical projection ..... *unca*

Mid-apical projection of second metasomal sternum, when present, not uncinate, either ventrally carinate or swollen and digitiform; apex of fourth metasomal sternum either truncate or rounded 10

10. Second metasomal sternum with no process or tumescence, its mid-apex with a shallow, narrow notch, ventral surface of sternum with a band of long black hairs extending along the median line, longest hairs medially, shortened both apically and basally; bristlelike hairs straight in median apical patch on fourth metasomal sternum ..... *integra*

Mid-apical process on second metasomal sternum present; bristlelike hairs on fourth metasomal sternum bent mesad at tips 11

11. Inferior apical angle of hind basitarsus produced, forming an acute but rounded angle; fourth metasomal sternum with median apical bare area about three times as wide at apex as at base. (Inner hind tibial spur no more than two thirds as long as hind basitarsus) ..... *odontogaster*

Inferior-apical angle of hind basitarsus not produced, either a a right angle or rounded; impunctate bare area in median apical patch of bristles on fourth metasomal sternum not over two times wider at apex than at base 12

12. Hind basitarsus widest in middle; process on mid-apex of second metasomal sternum ventrally carinate, appearing as a continuation of margin of sternum, which is triangular in outline (carina is rather weak in some specimens); ventral surface of sternum anterior to process flat, not modified; pubescence entirely light ..... *physariae*

Hind basitarsus widest at apex; process on mid-apex of second metasomal sternum arising abruptly from ventral surface of sternum, sub-apical, projecting beyond margin of sternum (very similar to process of *odontogaster*); ventral surface of sternum anterior to process with a concavity; pubescence usually mixed, black and white, in some specimens almost entirely light ..... *nifoata*

13. No truncation on lower margin of upper mandibular tooth; upper tooth thus triangular in outline or nearly so 21

Superior apical angle of mandible produced above a lower truncation so that the mandible approaches a four-toothed condition 14

14. Punctures on metasomal terga two to five extending to apices of terga, apical impunctate bands absent 15

Punctures on metasomal terga two to five not extending to apices of terga, apical impunctate bands present 17

15. Scopal hairs entirely white or white basally, fuscous toward apices; pubescence except that of tarsi white 16

Scopal hairs black; hair on metasomal terga black and white mixed; pubescence on clypeus and legs, except lower surfaces of tarsal segments, black ..... *sedula*

16. Hind tibial spurs dark brown; tegula dark brown, blue anteriorly; lower mandibular tooth at least one and one-half times longer than middle tooth; posterior scopal hairs fuscous toward apices ..... *prunorum*

Hind tibial spurs testaceous; tegula reddish testaceous; lower mandibular tooth subequal in length to middle tooth; scopal hairs entirely white. (Wings entirely covered with short, dense hairs) ..... *titusi*

17. Clypeus flat, punctures much coarser than those on rest of face; clypeal hairs recumbent and coarse ..... *trifoliama*

Clypeus convex, punctures equal to or only slightly coarser than those on rest of face; clypeal hairs erect 18

18. Hypostomal carina at least two times higher just behind angle than posteriorly, then rapidly reduced through angle; papillae on apex of fore wing coarse; clypeus weakly convex; hair on dorsum of thorax tawny to red ..... *integra*

Hypostomal carina low, if high, evenly raised; papillae on apex of fore wing fine, dense; clypeus moderately to strongly convex; hair on dorsum of thorax usually white or mixed, never red (some specimens of *franciscanis* are tawny) 19

19. Hair on face entirely black; strigilis with apex of malus produced into an elongate, slender, sharp spine; metasomal terga three to five with black hair. (Some specimens of *nigrifrons* may run here but are distinguished by the flattened hypostomal area with its fine punctures) ..... *franciscanis*

Hair on face either entirely white or black and white mixed; apex of strigilis obliquely acute, spine sharp or dull, but not elongate or slender; metasomal terga three to five with hair either mixed or entirely white 20

20. Scopal hair entirely white or testaceous; clypeal hair testaceous to white; hair on metasomal terga entirely white. Clypeus rather strongly convex ..... *lupinicola*

Scopal hair entirely black; clypeal hair black or black and white mixed; hair on metasomal terga black and white mixed. Clypeus moderately convex ..... *nigrobarbata*

21. Lower margin of upper mandibular tooth at least one and one-third times longer than upper margin of middle tooth; lower mandibular tooth at least two times longer than middle tooth 22

Lower margin of upper mandibular tooth subequal to upper margin of middle tooth; lower mandibular tooth no more than one and one half times longer than middle tooth 24

22. Ventral area of head, laterad of hypostomal carina, either flat or slightly concave; punctures of hypostomal area fine; lateroapical angles of clypeus concavely arcuate. (Apical impunctate bands of metasomal terga about one sixth as wide as punctate portion.) ..... *nigrifrons*

Ventral areas of head, laterad of hypostomal carina, convex; punctures of hypostomal area coarse; latero-apical angles of clypeus entire 23

23. Strigilis with its apex obliquely acute, spine short; hypostomal carina three times higher just behind angle than posteriorly, rapidly reduced through angle; first segment of flagellum twice as long as pedicel; hair on dorsum of thorax tawny to red. Apical impunctate bands of metasomal terga about one fourth as wide as punctate portion ..... *longula*

Strigilis with apex of velum subtruncate, apex of malus produced into a long, slender, sharp spine; hypostomal carina highest well back of angle, not over two times higher than posteriorly, gradually reduced to angle; first segment of flagellum one and three fourths times longer than pedicel; hair on dorsum of thorax white, sometimes mixed. Apical impunctate bands of metasomal terga about one seventh as wide as punctate portion ..... *hurdi*

24. Hair on sides of thorax entirely white 25

Hair on sides of thorax usually entirely black or fuscous, sometimes mixed 27

25. Scopal hair white to testaceous ..... *lupinicola*

Scopal hair black or fuscous, never light 26

26. Apical impunctate bands on metasomal terga two to five at least one fourth as wide as punctate portion; hind tibial spurs with their apical fourths strongly curved; hair on dorsum of thorax entirely white; metasomal terga three to five usually with a few black hairs mixed in the white ..... *dakotensis*

Punctures on metasomal terga extending nearly to the apices of the terga; hind tibial spurs straight or only slightly curved at tips; hair on dorsum of thorax with sparse black hairs mixed in white; metasomal terga with pubescence white ..... *liogastra*

27. Hair on dorsum of thorax entirely white; outer hind tibial spur (shorter one) more strongly curved in its apical one third than inner (longer one) ..... *giliarum*

Hair on dorsum of thorax black and white mixed; outer hind tibial spur not more strongly curved than inner 28

28. Inner hind tibial spur abruptly bent towards basitarsus two thirds length of spur from base; body length 11 mm. or more .. *calcarata*

Inner hind tibial spur straight or gradually curved, if bent, bending away from basitarsus; body length 10 mm. or less 29

29. Hind tibial spurs thick, at least one eighth as wide as long ... *nifoata*

Hind tibial spurs slender, usually straight, no more than one tenth as wide as long 30

30. Apical impunctate bands on metasomal terga with heavy subapical fringes of white hairs which extend beyond apical margins of terga ..... *giffardi*

Apical impunctate bands on metasomal terga with thin subapical fringes of dark hairs, or if fringes have white hairs, fringes thin and hairs fine 31

31. Apical impunctate bands on metasomal terga not less than one fifth as wide as punctate portion, bands minutely lined and usually shining; widespread species ..... *physariae*
Apical impunctate bands on metasomal terga not more than one sixth as wide as punctate portion, bands checkered and dull; species apparently restricted to deserts of southern California, *morongana*

Osmia lanei Sandhouse

(Plate XL, fig. 9; Plate XLI, fig. 7; Plate XLII, fig. 7; Plate XLIII, fig. 6; Plate XLIV, figs. 13, 14)

Osmia lanei Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 51 (male).

This species is very closely related to *O. giffardi* Sandhouse, distinguished by the shorter second metasomal sternal process, which has a wider ventral furrow, and which is much wider at the apex. The mid-apical projection of the sixth metasomal sternum is shorter and wider than in *giffardi*. It is distinct from other species in this subgenus by the following combination of characters: two groups of straight, mid-apical bristles on the ventral surface of the fourth metasomal sternum; the wider apical flagellar segment; and the swollen mediotarsal segments of the middle legs. The process of the gonocoxite of *lanei* is much more slender than the widened spatulate process of *giffardi*.

Male: Length of body, 10½ to 12 mm.; fore wing, 7 to 7½ mm.

Mandible black; flagellum hardly darker above than below; legs dark brown except metallic femora, fore and middle tibiae (some specimens with legs entirely brown). Body color dark olive green (some with a golden tint). Hair: On genae, middle and hind femora, sides of propodeum, metasomal terga, metasomal sterna (except golden fringes on mid-apices of three and five), black and white mixed; on lower surfaces of all tarsal segments reddish brown; elsewhere white to tawny; posterior surface of fore leg fringed with white from coxa to last tarsal segment, of middle leg from tibia to last tarsal segment.

Mandible with narrow, deep, V-shaped notch separating upper tooth from long, slender lower tooth; apical edge above notch oblique, unmodified, superior apical angle obtuse; mandibular carinae parallel, upper carina about two times wider, slightly higher medially, than lower carina, space between them narrow (Plate XL, fig. 9). Trophi: Length of first segment of labial palpus is to second as 7.0:7.1; relative lengths of segments of maxillary palpus from base to apex as 10:12:15:10:4. Clypeus convex, apex unmodified; punctures much finer than those on rest of face; apical impunctate band about one sixth as wide medially as greatest

width of scape. Postocellar and ocellocular lines subequal, ocelloccipital about one fourth shorter. Hypostomal carina, low, gradually increased from posterior end to just behind angle. Flagellum weakly crenulate, last segment with its inner margin produced, one third wider at its widest portion than preceding segments. Tibial spines on middle legs one third longer than on fore legs. Strigilis with apex obliquely acuminate, apex of malus produced into a slender, sharp, downward projecting spine. Segments of mediotarsus of fore leg swollen, subequal in width, two times wider than long, progressively shorter from second to fourth segment; basitarsus of uniform width, two and one-half times longer than wide. Middle coxa unmodified; mediotarsal segments similar to those of fore leg, subequal in width, second tarsal segment slightly wider than long, three and four progressively shorter. Hind basitarsus widest in middle, apex truncate; hind tibial spurs slender, gently curving for entire length. Papillae on apex of fore wing fine, dense; hair in cells short, moderately thick. Propodeal triangle finely lined, shining below, dull and reticulate above. Metasomal terga: Apical impunctate bands of terga one to five one third as wide as punctate portions; bands on one and two finely lined, shining, on three to five heavily lined, duller; sixth tergum with apical third slightly turned up, surface smooth, mid-apex weakly emarginate; seventh with mid-apical emargination of produced portion wide, shallow, U-shaped, on each side of emargination tooth is as wide as or wider than emargination. Metasomal sterna: First with a shallow mid-apical emargination on each side of which the margin is weakly produced; second with a very wide median-ventral furrow extending from its base through apex of projection, furrow three times as wide at its base as at its apex, projection appearing as a short, wide, truncate continuation of the mid-apex of sternum (no thicker than sternum, at least one half as wide at apex as width of hind basitarsus medially), lateral subapical fringes long, black and white mixed; third with a broad, shallow, mid-apical emargination continued anteriorly on ventral surface as a short, shallow groove which is lined with thick fringes of long golden hairs which extend well beyond the margin of sternum; fourth triangular in outline, with median apical patch of bristle-like hairs surrounding a wide, oblong, impunctate portion which hardly extends to apex of sternum, central apical bristles straight, in two distinct groups, others bent mesad at tips, lateral patches of slender, straight, black hairs not as large as in *giffardi* (Plate XLI, fig. 7); fifth with a broad, deep, U-shaped emargination, in front

of which is a patch of coarse spinelike hairs, lateral hairs of coarse patch continue into emargination as thin, golden hairs forming a fringe; sixth with subtruncate, mid-apical projection broad, hardly extending beyond margin of sternum, apex of projection with wide, shallow, V-shaped emargination on each side of which is a divergent tooth, anterior to emargination is a weak, V-shaped carina (projection much wider than in *giffardi*, Plate XLII, fig. 7). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 6, and Plate XLIV, figs. 13, 14.

Distribution: Known only from California, but ranging from the mountains of central California to Siskiyou County. Thirteen specimens have been studied from the following localities: Wright's Lake, Eldorado County, August 2, 1948 (P. D. Hurd); Gold Lake, Sierra County, July 10 and 13, 1921 (C. L. Fox); Buck's Lake, Plumas County, June 23, 1949 (J. W. McSwain); Mount Lassen, July 14, 1934 (E. P. Van Duzee); Walker, Siskiyou County, June 1, 1920 (C. L. Fox).

The type specimens are in the United States National Museum.

Osmia giffardi Sandhouse

(Plate XXXIX, fig. 12; Plate XL, fig. 8; Plate XLI, fig. 8; Plate XLII, fig. 6; Plate XLIII, fig. 7; Plate XLIV, fig. 10)

Osmia giffardi Sandhouse, 1939, Mem. Ent. Soc. Washington, No. 1, p. 50 (male and female).

The male of this species is very closely related to *O. lanei* Sandhouse, distinguished by the longer, subtriangular process on the second metasomal sternum. The process has a narrower ventral furrow, and is about one half as wide at the apex as in *lanei*. The mid-apical projection of the sixth metasomal sternum is longer and narrower than in that species. One of the most outstanding characteristics of this species is the greatly enlarged, spatulate process of the gonocoxite. It is distinct from other species in this subgenus because of the group of straight, mid-apical bristles on the ventral surface of the fourth metasomal sternum which projects beyond the margin of the sternum; also by the wider apical flagellar segment and the swollen mediotarsal segments of the middle legs.

The female is very close to *O. pellax*, *O. dakotensis*, *O. giliarum*, and *O. physariae*, distinguished from them by the longer lower mandibular tooth which is separated from the middle tooth by a deeper, V-shaped notch; also by the thick fringes of white hairs which extend over the apical impunctate bands of the metasomal terga.

Sandhouse (1939) added a very short paragraph about the females of this species to the end of her description of the male with the statement that they were tentatively assigned here. The only reason for this association is because the two sexes were taken together (not in copulation) at Summit, Placer County, California. In the absence of additional information the association is accepted.

Male: Length of body, 9 to 10½ mm.; fore wing, 6½ to 7 mm.

Mandibles black to dark brown; flagellum black above, dark brown below; legs dark brown (some specimens with metallic femora and tibiae). Head, dorsum of thorax, abdomen, olive green; sides of thorax, propodeal triangle, blue (some specimens have head, thorax, propodeal triangle, dark blue; abdomen greenish blue). Hair: On punctate portion of third to sixth metasomal terga, black and white mixed (varying from predominantly black to predominantly white); on lower surfaces of all tarsal segments light brown to reddish barown; elsewhere white, including fringe on posterior surface of fore leg extending from coxa to last tarsal segment, fringe on posterior surface of middle leg from tibia to last tarsal segment; fringes extending over apical impunctate bands of third to fifth metasomal terga.

Mandible with narrow, deep, V-shaped notch separating upper tooth from long, slender lower tooth; apical edge above notch oblique, unmodified; superior, apical angle obtuse; mandibular carinae parallel, upper carina about two times wider, slightly higher medially, than lower carina (hardly distinguishable from mandible of *lanei*), space between them narrow (Plate 11, fig. 8). Trophi: Length of first segment of labial palpus is to second as 7:9; relative lengths of segments of maxillary palpus from base to apex as 9:10: 16:10:3. Clypeus convex, apex unmodified; punctures much finer than those on rest of face; apical impunctate band about one-eighth as wide medially as greatest width of scape. Postocellar and ocellocular lines subequal, ocelloccipital about one third shorter. Hypostomal carina low, gradually increased from posterior limits to just behind angle. Flagellum weakly crenulate, last segment with inner margin produced, one-third wider at its widest portion than preceding segments. Tibial spine on middle leg slightly longer and stouter than on fore leg. Strigilis with apex of velum truncate, inner apical angle almost semicircular, apex of malus produced into a very thin, sharp spine which projects sharply downward. Segments of mediotarsus of fore leg swollen, subequal in width, two times wider than long, progressively shorter from second tarsal segment (not as wide but longer than in *lanei*); basitarsus uni-

formly widened, two and one half times longer than wide. Middle legs with coxa unmodified; mediotarsal segments similar to those of fore leg, second tarsal segment about as wide as long, three and four progressively narrower, shorter. Hind basitarsus gradually broadened from base to middle, then decreased to truncate apex; hind tibial spurs slender, gently curving for their entire length. Papillae on apex of fore wing fine, dense; hair in cells short, rather sparse. Metasomal terga: Apical impunctate bands of terga one through five about one third as wide as punctate portions; bands on one and two finely lined and shining, on three through five heavily lined, dull; sixth tergum with apical one third slightly turned up, surface smooth, mid-apex weakly emarginate; seventh with mid-apical emargination of produced portion wide, deep, U-shaped, on each side of which the tooth is blunt, as wide as emargination. Metasomal sterna: First with a very shallow mid-apical emargination on each side of which the margin is weakly produced; second with a median triangular furrow extending from its base to apex of mid-apical projection, which appears as a long, sub-triangular continuation of mid-apex of sternum (no thicker than sternum, not more than one third as wide as hind basitarsus medially), lateral, subapical fringes thin, of long, white hairs; third with a broad, shallow, mid-apical emargination continued anteriorly on ventral surface as a short, shallow groove that is lined with recumbent golden hairs extending posteriorly beyond margin of sternum; fourth broadly triangular in outline, with median, apical patch of bristlelike hairs surrounding a rather narrow, ovate, impunctate portion which extends to apex of sternum, central, apical bristles straight, not in two distinct groups, other bristles bent mesad at tips, lateral patches of rather dense, straight, black hairs (Plate XLI, fig. 8); fifth with a broad, rather deep, mid-apical emargination which is fringed with subapical, fine, white hairs; sixth with subtruncate, mid-apical projection narrow, its apex with a shallow, rather narrow, U-shaped emargination on each side of which the tooth is straight, V-shaped carina absent (Plate XLII, fig. 6). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 7, and Plate XLIV, fig. 10.

Female: Length of body, 8½ to 9 mm.; fore wing 6½ to 7 mm.

Vertex of head and dorsum of thorax, light olive green to greenish blue; metasomal terga dark olive green to dark greenish blue; face, propodeal triangle, sides of thorax and abdomen, dark blue; genae, propodeum except triangle, blue to greenish blue; ventral body surfaces, except metasoma, brown to black (hypostomal area in

one specimen metallic). Legs brown to black. Hair: On propodeum, metasomal tergum one, white; on face except clypeus, vertex of head, dorsum of thorax, metasomal terga two to five, black and white mixed (black hair on face, vertex of head, dorsum of thorax, coarser and longer than white hair; hair on metasomal terga predominately black on punctate portion, with apical impunctate bands heavily fringed with white hair which extends beyond the apical margins of sterna); metasomal tergum six clothed with recumbent white hairs which give that structure a silvery appearance; on upper surface of fore tarsus golden; on lower surfaces of fore and middle tarsi reddish brown; on lower surfaces of hind tarsus and tibia red; apices of femora fringed with short white hairs; elsewhere black.

Mandible with superior apical angle acute; no lower truncation on triangular upper tooth, which is equal in length to triangular middle tooth, lower margin of which is slightly convex and upper margin concave, the two teeth being separated by a wide, deep, V-shaped emargination; lower tooth longer (one and one-half times longer than middle tooth), slender, separated from middle tooth by a deep, V-shaped notch; mandibular carinae parallel, equal in width and equally raised, space between them narrow; apex two and one-half times wider than constriction (Plate XXXIX, fig. 12). Trophi: Length of first segment of labial palpus is to second as 7:8; relative lengths of segments of maxillary palpus from base to apex, as 7:10:11:8:4. Clypeus convex; punctures apically finer than, basally subequal to those on rest of face; apical impunctate band three-fourths as wide medially as greatest width of scape, with transverse furrow. Ocelloccipital and ocellocular lines equal, postocellar two-thirds shorter. First segment of flagellum subequal in length to pedicel. Hypostomal carina low, evenly raised; hypostomal area in general convex, punctures moderately fine. Tibial spines on fore and middle legs evenly produced. Longest hairs on fore basitarsus three-fourths as long as basitarsus. Strigilis with apex obliquely acute, spine short, sharp, inner apical angle hardly rounded (nearly angulate). Hind tibial spurs long, slender, straight (only slightly curved at apices). Papillae on apex of fore wing fine, dense; hairs in cells short, thick. Mesoscutum shining, punctures contiguous to widespread in middle, coarser and much deeper than very fine, shallow punctures on metasomal terga. Propodeal triangle dull and reticulate above, polished below. Apical impunctate bands on metasomal tergum one practically absent, on terga two to five at least one third as wide as punctate portions; bands heavily lined, rather dull.

Distribution: Known only from the Sierra Nevada of California, from Fresno County to Plumas County. The following include all the localities of the eighty-four specimens studied: Huntington Lake, Fresno County, July 7, 1919 (E. P. Van Duzee); Dead Man's Creek, Alpine County, June 20 (C. D. Michener); Wright's Lake, Eldorado County, July 2, 1948 (P. D. Hurd); Summit, Placer County (W. M. Giffard, paratypes); Gold Lake, Sierra County, July, 1921 (C. L. Fox); Buck's Lake, Plumas County, June 24, 1949 (P. D. Hurd).

The type specimens are located in the United States National Museum.

Osmia ashmeadii (Titus)

Acanthosmioides ashmeadii Titus, 1904, Proc. Ent. Soc. Washington, vol. 6, p. 101 (male).
Osmia ashmeadii, Michener, 1936, American Mus. Novitates, no. 875, p. 27 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 47.

Since the author has not seen the single type specimen, the following description has been rearranged from Sandhouse (1939), additional information having been supplied by Mr. Karl V. Krombein. It probably differs from other species in this subgenus by the carinate first metasomal sternum, the strongly compressed process on the second metasomal sternum, and the stout, strongly curved hind tibial spurs. This species has not been included in the key.

Male: Length of body, 11 to 12 mm.

Greenish blue in color, slightly more greenish on face and dorsum of thorax. Hair: On temple, metapleuron, side of propodeum, third to seventh metasomal terga, metasomal sterna, except golden fringe on emargination of third, black; on rest of head and thorax, fore legs, and apparently on first two metasomal terga, white; on lower surfaces of tarsi reddish; on middle and hind legs a mixture of black and white.

Mandible with the upper tooth almost truncate, separated from large, lower tooth by a V-shaped emargination; superior apical angle obtuse. Trophi: Segments of maxillary palpus long and slender, second two thirds as long as third, which is equal to combined lengths of fourth and fifth. Clypeus with apical impunctate band rather narrow; punctures on clypeus finer than those on rest of face. Ocelloccipital, ocellocular, and postocellar lines about equal. Hypostomal carina low, almost uniformly raised. Antennae of type missing. Tibial spine smaller on fore leg than on middle leg. Apex of strigilis almost truncate (any spine or projection might have worn off). Segments of fore tarsus uniformly wide, first segment longer than second, mediotarsal segments wider than

long; basitarsus three times as long as wide. Middle legs with mediotarsi missing in type; basitarsus swollen, basal half more strongly swollen along lower margin. Hind basitarsus twice as long as wide, uniformly widened; hind tibial spurs stout and strongly curved at apices. Propodeal triangle shining, with lower portion polished, above weakly lined. Metasomal terga: Apical impunctate bands of two, one fourth, three, one third, four and five, one half as wide as punctate portions; sixth with apical margin strongly convex; seventh with produced portion wide, with a large, deep, mid-apical emargination on each side of which is a wide tooth. Metasomal sterna: Apical half of first with a strong median carina; second with mid-apical process arising two thirds length of sternum from base of exposed part of sternum, strongly compressed, ventral margin carinate, process extending for two thirds its length beyond apex of sternum, in profile process tapering slightly toward apex, which is broadly rounded; third with a narrow, V-shaped, mid-apical emargination which has a fringe of long hairs; fourth with a rounded, median, apical patch of coarse black bristles which is divided medially by a wide, nonpubescent stripe; fifth with a wide, shallow mid-apical emargination; sixth with a wide, median projection of the apical margin, apical-lateral angles rounded on each side of a median emargination. Genitalia in general characters very similar to those of *odontogaster,* but process on gonocoxite longer and more slender.

Distribution: Dalles, Oregon; known only from the single type specimen.

The type specimen is in the United States National Museum.

Osmia watsoni Cockerell

Osmia watsoni Cockerell, 1911, Trans. American Ent. Soc., vol. 37, p. 235 (male); Cockerell, Univ. Colorado Studies, vol. 16, p. 116 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 48 (male).

Since the author has not seen any of the types or specimens of this species, the following description has been rearranged from Sandhouse (1939), additional information having been supplied by Mr. Karl V. Krombein. It probably differs from other species in the subgenus in the absence of any definite process on the second metasomal sternum (a low, rather wide apical tumescence is present) combined with the widened, apical, flagellar segment. This species has not been included in the key of this revision.

Male: Length of body, 11 to 12 mm.

Olive green in color, slightly more bluish green on temple and sides of thorax; flagellum with distal two thirds of apical joint black;

femora with slight metallic tints, tarsi reddish; metasomal sterna two to four dark brown, second with obscure metallic tints. Hair: On middle and hind tarsi and metasomal sterna two to four mostly reddish, elsewhere creamy white.

Mandible with upper truncate tooth separated from slender lower tooth by a narrow emargination; superior-apical angle acute and slightly produced. Apical impunctate band of clypeus moderately wide in middle, narrower at sides; punctures on clypeus finer than those on rest of face. Ocelloccipital, ocellocular, and postocellar lines as 8.5:6.0:7.0. Hypostomal carina rather low, highest at angle, uniformly raised posteriorly. Flagellum with segments one to ten about one and one-half times as long as wide; apical segment longer with its distal two-thirds widened gradually to tip which is one fourth wider than preceding segments. Tibial spine on fore leg smaller than on middle leg. Strigilis with apex of velum truncate, inner-apical angle hardly rounded (almost angulate), apex of malus produced into a stout, straight, sharp spine. Segments of fore tarsus slender, basitarsus four times as long as wide. Middle basitarsus slightly swollen. Basitarsus of hind leg compressed, lower surface strongly convex on apical half, other segments progressively shorter; hind tibial spurs slender and straight. Propodeal triangle shining, lower half polished, upper half with fine irregular carinae. Metasomal terga: Apical impunctate bands of terga two to five at least one fourth as wide as punctate portion, bands finely lined; sixth tergum with a shallow, rounded mid-apical emargination; seventh with its apical one third produced with a rounded, deeper than wide, mid-apical emargination, on each side of which is a narrow tooth. Metasomal sterna: Second with apical margin convex, tumescence on ventral surface wide, very low, its pubescence entirely pale, less erect, somewhat shorter than dark, lateral patches of hairs; third with a wide, mid-apical emargination; fourth with lateral portions rather densely punctured and pubescent, middle third with coarser, slightly wavy bristles, the tips of which bend mesad, with a wide median impunctate band, apical margin of sternum strongly produced in the middle, with its sides converging to truncate apex, which is about one third basal width; fifth with mid-apical concavity broad, shallow, fringed with long, fine, golden hairs; sixth with the produced portion narrow. Genitalia very similar to those of *odontogaster*, but process on coxopodite longer, more slender, apex of gonocoxite narrower, angles rounder.

Distribution: Albuquerque, New Mexico; known only from the type specimens.

The type specimens are in the United States National Museum.

Osmia obliqua new species

(Plate XL, fig. 7; Plate XLI, fig. 5; Plate XLII, fig. 2; Plate XLIII, fig. 9; Plate XLIV, figs. 1, 5)

This species is closely related to *O. odontogaster* Cockerell, from which it is distinguished by the oblique upper mandibular tooth, the obtuse superior-apical angle of mandible, and the longer hind tibial spurs as compared to length of hind basitarsus. It is easily separated from other species in this subgenus by the produced inferior, apical angle of the hind basitarsus. This species also differs from *odontogaster* in that rarely do any specimens have entirely white hair on the metasomal terga as is the case in *odontogaster*. In the material studied little variation was noticed; only two specimens had entirely white hair on the abdominal terga; there is considerable variation in the degree of slant of the upper mandibular tooth. Although specimens of *obliqua* have been taken with *odontogaster* at several localities, they apparently do not intergrade with that species. Previous authors have usually confused *odontogaster* and *obliqua,* although some specimens of *obliqua* have ben labeled as "*physariae* (?)."

Male: Length of body, 8½ mm. (7 to 9 mm. among paratypes); fore wing, 6½ mm. (5½ to 6½ mm. among paratypes).

Mandible black (varying to reddish brown among paratypes), metallic at base; flagellum black above, light below; legs light brown (varying to dark brown among paratypes), except metallic upper surfaces of femora and tibiae of more deeply colored specimens. Propodeal triangle greenish blue; elsewhere dark olive green (varying among paratypes: head, thorax, abdomen, propodeal triangle, greenish blue; head, thorax blue, propodeal triangle greenish blue, abdomen olive green). Hair: On metasomal terga two to five black and white mixed (rarely entirely white); lower surfaces of all tarsal segments reddish brown; posterior edge of middle basitarsus with reddish brown fringe; elsewhere white with the following features: posterior surface of fore leg fringed with white hair extending from coxa to last mediotarsal segment; posterior edge of femur and tibia of middle leg fringed with white hair, longest hairs on tibia twice as long as those on femur; fringes of white hair extending over apical impunctate bands of metasomal terga three to five.

Mandible with deep, V-shaped notch separating upper tooth from long, slender, lower tooth; apical edge above notch oblique, convex below, superior, apical angle obtuse; mandibular carinae

parallel, equal in width, about equally raised, space between them narrow (Plate XL, fig. 7). Trophi: Length of first segment of labial palpus is to second as 5:6; relative lengths of segments of maxillary palpus from base to apex as 9:10:13:7:5. Clypeus convex, apex unmodified; punctures much finer than those on rest of face; apical impunctate band one third as wide medially as greatest width of scape. Postocellar and ocelloccipital lines equal, ocellocular shorter. Hypostomal carina low, uniform. Flagellum weakly crenulate, last segment no wider than preceding segments. Tibial spine on middle leg twice as long as on fore leg. Strigilis with apex of velum subtruncate, inner, apical angle strongly convex, apex of malus produced into a rather long, sharp, downward curving spine. Segments of mediotarsus of fore legs slightly swollen; fourth tarsal segment three fourths as wide as second, which is as wide as basitarsus; basitarsus evenly widened, one third as wide as long. Middle leg with coxa unmodified; tarsal segments not swollen, longer than wide. Hind basitarsus widest at apex, inferior apical angle produced making an acute angle; hind tibial spurs long, gently curving for their entire length, inner one about five sixths as long as basitarsus (always more than two thirds as long as basitarsus). Papillae on apex of fore wing fine, dense; hair in cells short, sparse. Propodeal triangle dull and reticulate above, polished below. Metasomal terga: Apical impunctate bands of terga one to five about one third as wide as punctate portion; bands one to three finely lined, shining, four and five checkered, rather dull; sixth tergum with apical fourth slightly turned up, surface smooth, mid-apex practically not emarginate; seventh with mid-apical emargination of produced portion deep, U-shaped, on each side of which the tooth is narrow, about one half as wide as emargination. Metasomal sterna: First with ventral surface flat, apex truncate with a very narrow, shallow concavity on mid-ventral surface immediately posterior of which the apex is produced as follows: a digitiform projection extending beyond apical margin of sternum with a median ventral groove causing the apex to be emarginate, as viewed laterally the ventral and dorsal surfaces converge toward rounded tip, distance from widest basal portion to apex is one fourth the length of hind basitarsus, margin of sternum each side of projection fringed with long, white hair; third with a shallow, rather narrow, mid-apical concavity fringed with short golden hair, apical margin of sternum fringed with long, tawny hair; fourth with median, apical one third produced, almost truncate,

its mid-apex with a slight projection, median, apical patch of bristlelike hairs bent mesad at tips, surrounding an impunctate portion which extends to apex where it is three times wider than at base, lateral patches sparse, black (Plate XLI, fig. 5); fifth with a semicircular, very deep, mid-apical emargination on each side of which the sternum is fringed with narrow, light hairs bending mesad at tips; sixth with a mid-apical produced portion, its apex with a shallow, wide, V-shaped emargination on each side of which is a divergent tooth, anterior to emargination is a slightly raised, V-shaped carina (Plate XLII, fig. 2). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 9, and Plate XLIV, fig. 5.

Distribution: Specimens studied were from California, Oregon and British Columbia. Holotype and three paratypes, Tetley's Mountain Camp, San Bernardino Mountains, California, on *Vicia americana*, May 16 (C. D. Michener); one paratype, Perris, Riverside County, California, on *Astragalus*, March 19, 1936 (F. R. Platt; this specimen represents the southernmost distribution of the species); one paratype, Priest Valley, Monterey County, California, April 10, 1938 (G. E. Bohart); one paratype, Mount Diablo, Contra Costa County, California, April 29, 1939; one paratype, Fairfax, Marin County, California, June 4, 1911 (E. C. Van Dyke); one paratype, Fish Camp, Mariposa County, California, June 10, 1942 (E. G. Linsley); one paratype, Mono County, California, June 26, 1937 (C. D. Michener); one paratype, Dead Man's Creek, Alpine County, California, June 26, 1937 (C. D. Michener); three paratypes, Buck's Lake, Plumas County, California, June 23, 1949 (J. W. MacSwain); one paratype, Lassen National Park, California, June 24, 1940 (I. McCracken); three paratypes, Eagle Ridge, Klamath County, Oregon, May 27, 1924 (C. L. Fox); three paratypes, Mount Hood, Oregon, June 25, 1925 (E. C. Van Dyke); one paratype, Sidney, British Columbia, May 8, 1915 (F. W. L. Sladen); one paratype, Lillooet, British Columbia, June 13, 1918 (A. W. A. Phair).

The holotype and four paratypes are located in the Snow Entomological Collection, University of Kansas; two paratypes will be sent to the United States National Museum; six paratypes will be returned to the University of California at Berkeley, eleven paratypes will be returned to the California Academy of Sciences; two paratypes will be returned to the Canadian National Collection; one paratype will be returned to G. E. Bohart; and one paratype will be sent to the American Musuem of Natural History.

Osmia nigrobarbata Cockerell

(Plate XL, figs. 5, 13; Plate XLI, fig. 10; Plate XLII, fig. 10; Plate XLIII, fig. 13; Plate XLIV, fig. 12)

Osmia nigrobarbata Cockerell, 1916, Pomona Jour. Ent. Zool., vol. 8, p. 53 (female); Sandhouse, 1924, Proc. California Acad. Sci., ser. 4, vol. 13, pp. 364, 369 (key, record); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 52 (female); Michener, 1949, Jour. Kansas Ent. Soc., vol. 22, p. 55 (male, female).

Osmia vanduzeei Sandhouse, 1924, Proc. California Acad. Sci., ser. 4, vol. 13, p. 343 (male); Michener, 1936, American Mus. Novitates, no. 875, p. 28 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 52 (male).

This species is very distinct among the males, because of the strongly oblique upper mandibular tooth and the uncinate process on the second metasomal sternum. It resembles large specimens of *O. unca* Michener but is readily separated by the upper mandibular tooth, which is transverse or at least has an acute superior apical angle in that species. *O. calcarata* new species resembles this male very closely, but is easily distinguished by the grooved second metasomal sternal process; also in *nigrobarbata* there is a spinelike, mid-apical projection on the fourth metasomal sternum. Hair color is not so variable among the males as among the females. The females resemble most closely those of *calcarata,* but are separated by the abruptly bent inner, hind, tibial spur in that species. *O. francisconis* new species and *O. nigrifrons* Cresson are sometimes confused with darker forms of *nigrobarbata;* however, even the dark forms have more white hairs than are ever found in those species. It should be mentioned here that usually the Southern Californian forms are darker with more dark hairs, becoming lighter toward the north, but that in large series from single localities it is possible to find every variation which occurs throughout the range of the species.

There is on hand one specimen from Walla Walla, Washington, which is slightly smaller than the Californian specimens, is darker in body color, and has more white hairs but is placed in this species because it is apparently very close and until further material is taken, nothing more can be done with it. Material is also on hand which includes specimens from Oregon, Saskatchewan, Idaho, and Utah, which cannot be distinguished morphologically from those of *nigrobarbata,* but are decidedly smaller. Further distributional data may show these to be a subspecies of *nigrobarbata,* the females of *O. unca* Michener, or even a new species. Complete locality information on these specimens is given later.

Male: Length of body, 12 to 14 mm.; of fore wing, 8 to 8½ mm.

Mandible black, metallic at base; flagellum dark above, light be-

low; legs dark brown to black except metallic femora. Body color varies; sides of abdomen dark blue, elsewhere olive green; or, vertex of head and sides of face olive green, elsewhere dark blue; or, vertex of head, dorsum of thorax, olive green, sides of thorax, propodeum, blue, elsewhere greenish blue. Hair: On metasomal terga three to five black and white mixed (in some specimens entirely white); lower surfaces of all tarsal segments, apical bristles on fourth metasomal sternum, reddish brown; elsewhere white including: fringes of white hair on posterior surface of fore leg from coxa to last mediotarsal segment, also of middle femur; fringes of white hair over apical impunctate bands of metasomal terga three to five (these fringes extend beyond the apices of the terga and are rather thick).

Mandible with deep, V-shaped notch separating upper tooth from very long, slender, lower tooth; apical edge above notch strongly oblique, convex below, nearly parallel with longitudinal axis of mandible above, a superior apical angle of nearly 180°; mandibular carinae parallel, upper carina greatly raised, twice as high as lower and one half as wide apically as basally, space between them narrow (Plate XL, fig. 13). Trophi: Length of first segment of labial palpus is to second as 8.0:8.1; relative lengths of segments of maxillary palpus from base to apex as 10:12:15:12:7. Clypeus convex, slightly concave mid-apically, weakly produced at sides; punctures basally subequal to, apically finer than those on rest of face; apical impunctate band one fifth as wide medially as greatest width of scape. Postocellar and ocellocular lines subequal, ocelloccipital longer. Hypostomal carina very low, practically not distinguishable. Flagellum strongly crenulate, last segment no wider than preceding segments. Tibial spine on middle leg about one third longer than on fore leg. Strigilis with apex of velum truncate, inner apical angle rounded, apex of malus produced into a short, sharp, downward curving spine. Segments of mediotarsus of fore leg weakly swollen; second and third tarsal segments equal in width, third slightly longer, fourth shorter and three fourths as wide as others; basitarsus three and one third times longer than wide. Middle leg with coxa unmodified; mediotarsal segments not swollen, longer than wide. Hind basitarsus with inferior apical angle a right angle, superior apical angle rounded, widest at apex; hind tibial spurs slender, gently curved. Papillae on apex of fore wing fine, dense; hair in cells short, thick. Propodeal triangle polished below, reticulate and dull above. Metasomal terga: Apical impunctate bands of terga two to five at least one-third as

wide as punctate portions, finely lined, shining; sixth tergum with apical one third slightly turned up, mid-apical margin barely concave; seventh with mid-apical emargination of produced portion, wide, shallow, on each side of which the tooth is subequal in width to emargination. Metasomal sterna: First with a median, ventral carina extending anteriorly from apex (in some specimens the carina is rather tumid), apical margin of sternum fringed with white hairs; second with a mid-apical, uncinate projection appearing as a continuation of margin of sternum, curved portion of process about two-thirds longer than width of sternum, which is subtriangular in outline, fringed with long white hair, ventral surface posterior to projection with a rather wide, elongate concavity; third with mid-apical emargination narrow, semicircular, thickly fringed with golden hairs, apical third of sternum with long hairs which laterally extend well beyond margin; fourth with median apical one third weakly produced, its mid-apex produced into a long, narrowly triangular, sharp spine (larger than in *unca*), median-apical patch of bristle-like hairs bent mesad at tips, surrounding a subrectangular, impunctate portion which extends to apex of sternum where it is widest, lateral patches thick, of long, black, thin hairs (Plate XLI, fig. 10); fifth with a broad, shallow, mid-apical concavity, thinly fringed with light hairs; sixth with mid-apical produced portion wide, its apex very shallowly concave (nearly truncate), on each side of which is a divergent tooth, anterior to apex is a V-shaped carina (Plate XLII, fig. 10). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 13, and Plate XLIV, fig. 12.

Female: Length of body, 10 to 12 mm.; fore wing 7 to 8 mm.

Vertex of head, dorsum of thorax, olive green; elsewhere dark blue; ventral body surfaces nonmetallic, black. Legs dark brown. Hair: On sides of face, dorsum of thorax, propodeum, first metasomal tergum, white; apex of clypeus, legs except tarsi, scopa, black; lower surfaces of all tarsal segments and hind tibia, reddish brown; elsewhere a mixture of black and white hairs. Hair color varies greatly: White areas may have black hairs mixed, except first metasomal tergum, which is consistently white; hair on terga four and five may be solidly black except white fringes over apical impunctate bands; usually the recumbent light hairs on tergum six give that structure a silvery appearance.

Mandible with superior apical angle produced above lower, oblique, truncate portion to make an acute angle; upper tooth equal in length to triangular middle tooth, separated from it by a rather deep, U-shaped notch; lower tooth longer (two thirds

longer than middle), slender, separated from middle by a wide, V-shaped notch; mandibular carinae parallel, both carinae raised, upper about one third higher medially, space between them narrow; apex of mandible two and one-half times wider than constriction (Plate XL, fig. 5). Trophi: Length of first segment of labial palpus is to second as 1:1; relative lengths of segments of maxillary palpus from base to apex as 10:11:15:10:7. Clypeus convex; punctures coarser than those on rest of face; apical impunctate band practically as wide medially as greatest width of scape, band has a transverse furrow. Ocelloccipital and ocellocular lines subequal, postocellar shorter. First segment of flagellum one and one-third times longer than pedicel. Hypostomal carina low, slightly higher well behind angle, gradually reduced forward; hypostomal area in general convex, punctures coarse. Tibial spines about evenly produced on both fore and middle legs. Longest hairs on fore basitarsus two thirds as long as basitarsus. Strigilis with apex obliquely truncate, spine short, inner-apical angle rounded. Hind tibial spurs long, slender, rather sharply curved at tips. Papillae on apex of fore wing fine, dense; hair in cells short, moderately thick. Mesoscutum dull to shining, punctures confluent, coarser than shallow, widespread punctures of metasomal terga. Propodeal triangle dull and reticulate above, finely lined and shining below. Apical impunctate bands of metasomal terga two to five at least one third as wide as punctate portions, of tergum one very narrow; bands heavily lined but shining (almost checkered).

Distribution: Known from California in the San Bernardino Mountains in the south to Placer County in the north, and one female specimen from Walla Walla, Washington. As was explained above there are on hand several small female specimens, the position of which is uncertain; following is complete locality information on these specimens: High Cascade Mountains, Horse Lake, Lane County, Oregon, June 25-31, 1909 (J. C. Bridwell); Indian Head, Saskatchewan, May 31, 1915 and Saskatoon, Saskatchewan, May 29, 1915 (F. W. L. Sladen); Kimberly, Idaho, June 28, 1934, on beans (H. Bergen); Hollister, Idaho, May 24, 1931 (D. E. Fox); Moscow, Idaho, June 6, 1912 (J. M. Aldrich); Logan, Utah, June 15, 1947 (R. L. Rigby).

The following is a list of selected localities taken from the two hundred and three more or less typical specimens studied: *California:* Perris, Riverside County, April 5, 1946 (W. F. Barr); Joshua Tree National Monument, Riverside County, May 26, 1941

(E. C. Van Dyke); Idyllwild, San Jacinto Mountains, June 29, 1928 (E. C. Van Dyke); Tetleys Mountain Camp, San Bernardino Mountains, May 16 (C. D. Michener); Fort Tejon, Kern County, May 5, 1947 (J. W. MacSwain); Stone Canyon, Monterey County, April 29, 1919 (E. P. Van Duzee); Antioch, Contra Costa County, April 9, 1939 (G. E. Bohart); Lone Pine, Inyo County, June 5, 1937 (C. D. Michener); Tehama County, April 27, 1913 (F. W. Nunenmacher). *Washington:* Walla Walla, May 29, 1937 (G. E. Bohart).

The present location of the type specimen of *nigrobarbata* is unknown; that of *vanduzeei* is in the collection of the California Academy of Sciences.

Osmia calcarata new species

(Plate XXXIX, fig. 15; Plate XL, fig. 11; Plate XLI, fig. 9; Plate XLII, fig. 9; Plate XLIII, fig. 11; Plate XLIV, fig. 15)

Males of this species superficially resemble *O. nigrobarbata* Cockerell but are easily distinguished by the second sternal process, which is not uncinate at its apex, and by the lower and narrower upper mandibular carina. The second sternal process very closely resembles that of *O. giffardi* Sandhouse but the flattened last flagellar segment and the swollen mediotarsal segments of the middle legs in that species easily separate the two. Females of *calcarata* are closest to *O. nigrifrons* Cresson but distinguished by the convex hypostomal area (ventral portion of head laterad of the hypostomal carinae), which has coarser punctures, also by the V-shaped notch separating the upper mandibular tooth from the middle tooth, and the shape of the clypeal margin. The female is easily separated from *nigrobarbata* by the absence of any truncation on the upper mandibular tooth. The sexes of this species are easily associated by the peculiar bend of the inner hind tibial spur, also by the wide, shining, apical bands of the metasomal terga.

Male: Length of body, 12½ mm. (among paratypes 11½ to 12½ mm.); fore wing, 9 mm. (paratypes 8½ to 9 mm.).

Mandible black, base nonmetallic (metallic among some paratypes); flagellum black above, dark brown below; legs brown, except metallic fore and hind femora. Vertex of head, dorsum of thorax, sides of thorax, propodeum (except triangle), first metasomal tergum, light olive green; genae, face, propodeal triangle, sides of abdomen, blue; elsewhere, dark greenish blue (paratypes vary considerably in body color, especially those which have greenish blue genae and dark blue sides of the thorax). Hair: On

face, hypostomal areas, dorsum of thorax, mesepisternum, propodeum (except lateral black patches), and first metasomal tergum (except very thin lateral black patches) white; fringes on posterior femora and pubescence of fourth to fifth metasomal terga black; posterior margin of fore leg fringed with white from coxa to last mediotarsal segment; hair of fore tarsi golden; hair on lower surfaces of middle and hind tarsi reddish brown; elsewhere black and white mixed (paratypes vary little, notably in the size of black patches on sides of thorax, and presence of scattered, sparse white hairs on terga four to six).

Mandible with a narrow, shallow, V-shaped notch separating upper tooth from long, wide, lower tooth; apical edge above notch oblique, unmodified, superior apical angle obtuse; mandibular carinae parallel, upper carina slightly higher than lower carina, space between them narrow (Plate XL, fig. 11). Trophi: Length of first segment of labial palpus is to second as 9:11; relative lengths of segments of maxillary palpus from base to apex as 10:16:17:10:7. Clypeus strongly convex, apex unmodified; punctures finer than those on rest of face; apical impunctate band narrow, being one sixth as wide medially as greatest width of scape. Ocelloccipital and ocellocular lines subequal, postocellar shorter. Hypostomal carina moderately high, gradually increased from posterior limit to beyond angle. Flagellum weakly crenulate, last segment no wider than preceding segments. Tibial spine on fore leg two thirds as long as that on middle leg. Strigilis with apex of velum truncate, inner apical angle semicircular, apex of malus produced into a short, stout, downward projecting spine. Segments of mediotarsus of fore leg swollen; second tarsal segment slightly wider than long, three and four progressively shorter and narrower (anterior and posterior lobes evenly produced); basitarsus gradually widened from base to apex where it is one third as wide as long. Middle leg with coxa unmodified; tarsal segments not swollen, longer than wide. Hind basitarsus gradually widened from base to broadly rounded apex; hind tibial spurs long, slender, inner one abruptly bent medially, outer one curved only at tip. Papillae on apex of fore wing fine, dense; hair in cells short, dense. Propodeal triangle dull and reticulate above, finely lined and shining below. Metasomal terga: Apical impunctate bands of terga two to five at least one third as wide as punctate portions, checkered, shining; sixth tergum with apical one third slightly turned up, apical edge turned down, surface smooth, mid-apex practically not emarginate; seventh with mid-apical emargination of produced portion deep,

on each side of it the tooth is long, not as wide as emargination, rather sharp. Metasomal sterna: First triangular in cross section, with a small, rounded mid-apical projection; second with its ventral surface broadly concave, mid-apex produced as follows: a triangular, digitiform projection extending well beyond apical margin of sternum, apex of projection truncate and one fourth as wide as at base, with shallow, narrow groove extending from apex to wider concavity on ventral surface of sternum, concavity narrowing rapidly anteriorly and extending to base of sternum as narrow, median groove; third with mid-apical emargination deep, rather wide, fringed with long hairs, apical halves of which are golden, basal halves dark, apical half of sternum heavily clothed with long black hairs; fourth with median, apical third produced, apex truncate, median apical patch of bristlelike hairs surrounding an oblong, impunctate portion which extends to mid-apex of sternum, central apical bristles straight, black (Plate XLI, fig. 9); fifth with a broad, deep, mid-apical emargination which is thinly fringed with light colored hairs; sixth with a mid-apical produced portion, its apex with a broad, shallow concavity, on each side of which is a divergent, blunt tooth, anterior to concavity is a V-shaped carina (Plate XLII, fig. 9). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 11, and Plate XLIV, fig. 15.

Female: Length of body 11½ mm. (among paratypes 11 to 12 mm.); fore wing 9 mm. (among paratypes 8½ to 9 mm.).

Dorsum of thorax, vertex of head, supra-antennal areas, light olive green; propodeal triangle blue; elsewhere greenish blue; ventral body surfaces non-metallic, dark brown. Legs dark brown except apical metallic patch on posterior surface of fore femur. Hair: On dorsum of thorax, vertex of head, propodeum, second metasomal tergum, black and white mixed (white predominant on thorax); first metasomal tergum, except thin lateral black patches, white; sixth metasomal tergum with a median patch of recumbent white hair; upper surface of fore tarsus golden, of middle tarsus reddish brown; lower surfaces of all tarsal segments reddish brown; apices of fore and middle femora with black fringes, of hind femora with white fringes (some paratypes with all fringes dusky); elsewhere black.

Mandible with superior, apical angle acute; no lower truncation on triangular upper tooth which is equal in length to triangular middle tooth, the two being separated by a wide, deep, V-shaped notch; lower tooth very long (twice as long as middle), slender, separated from middle tooth by a narrow, deep, V-shaped notch;

mandibular carinae raised, upper about two times higher medially, space between rather wide, widest at apex, reduced toward base of mandible; apex of mandible two and one-fourth times wider than constriction (Plate XXXIX, fig. 15). Trophi: Length of first segment of labial palpus is to second as 8:9; relative lengths of segments of maxillary palpus from base to apex as 12:14:15:14:7. Clypeus rather strongly convex; punctures apically equal to those on rest of face, coarser basally; apical impunctate band five sixths as wide medially as greatest width of scape, with a transverse furrow. Postocellar and ocellocular lines subequal, ocelloccipital longer. First segment of flagellum one and one third times longer than pedicel. Hypostomal carina low, slightly higher well behind angle, gradually reduced posteriorly and anteriorly from point of greatest heighth; hypostomal area in general convex, punctures coarse. Tibial spine on fore leg slightly longer than that on middle leg. Longest hairs on fore basitarsus two thirds as long as basitarsus. Strigilis with apex obliquely acute, spine short, blunt, inner apical angle only slightly rounded (almost angulate). Hind tibial spurs very long, inner one abruptly bent at apical third, outer one curved only at tip. Papillae on apex of fore wing fine, dense; hair in cells short, moderately thick. Mesoscutum dull, punctures contiguous, coarser and much deeper than fine, shallow punctures of metasomal terga. Propodeal triangle dull and reticulate above, finely lined and shining below. Apical impunctate bands of metasomal terga two to five about one half as wide as punctate portions, absent on tergum one; bands checkered, shining.

Distribution: Known only from Sonora Pass in California; this pass is located on the Calaveras-Tuolumne County line. Holotype male, allotype female, three male and three female paratypes, Summit of Sonora Pass, Sierra Nevada Mountains, June 27, 1937 (C. D. Michener); six male and five female paratypes from the type locality, June 26, 1937 (E. C. Van Dyke).

The holotype, allotype, three male and three female paratypes are in the Snow Entomological Museum, University of Kansas; two male and two female paratypes will be deposited in the United States National Museum; and one male and one female paratype will be deposited in the American Museum of Natural History. Four male and three female paratypes will be returned to the California Academy of Sciences. One male and one female paratype will be sent to the University of California at Berkeley.

Osmia sladeni Sandhouse

(Plate XL, fig. 10; Plate XLI, fig. 6; Plate XLII, fig. 8; Plate XLIII, fig. 10; Plate XLIV, fig. 11)

Osmia sladeni Sandhouse, 1925, Canadian Ent., vol. 57, p. 33 (male); Cockerell, 1928, Univ. Colorado Studies, 16, p. 125 (record); Michener, 1936, American Mus. Novitates, no. 875, p. 28 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 55.

This species resembles *O. nifoata* Cockerell rather closely, but is distinguished by the oblique upper mandibular tooth, the obtuse superior apical angle, and the laterally compressed process on the second metasomal sternum. Generally it is larger than either *nifoata* or *O. physariae* Cockerell and easily distinguished from both by the much larger median apical, impunctate portion of the ventral surface of the fourth metasomal sternum.

Sandhouse (1939) placed this species in synonymy with *nifoata* but in view of the characters mentioned above it is here regarded as an entirely distinct species.

Male: Length of body, 10½ to 11½ mm.; fore wing 7½ to 8 mm.

Mandible black to brown, apex red, base metallic; flagellum usually lighter below than above; legs usually black except metallic fore and hind femora. Face, sides of thorax, propodeum, blue; rest of head, dorsum of thorax, olive-green; metasomal terga dark greenish blue. Hair: Not as variable as in *nifoata;* on face, vertex of head, dorsum of thorax, posterior surface of fore leg from coxa to last mediotarsal segment, white; mesepisternum, sides of propodeum, sides of first metasomal tergum, usually white but some specimens with dusky patches; metasomal terga three to five (some specimens with sparse, pale hairs extending over apical impunctate bands), metasomal sterna (except golden, mid-apical fringe on third), black; lower surfaces of all tarsal segments reddish brown; elsewhere black and white mixed.

Mandible with a rather wide, deep, V-shaped notch separating upper tooth from very long, lower tooth; apical edge above notch oblique, unmodified, superior apical angle obtuse; mandibular carinae parallel, lower carina slightly wider than upper, space between them narrow (Plate XL, fig. 10). Trophi: Length of first segment of labial palpus is to second as 6:7; relative lengths of segments of maxillary palpus from base to apex as 9:11:16:9:5. Clypeus convex, apex unmodified; punctures on clypeus same as areas immediately surrounding, finer than those on rest of face; apical impunctate band about one third as wide medially as greatest width of scape. Postocellar and ocellocular lines subequal, ocel-

loccipital longer. Hypostomal carina low, highest behind angle. Flagellum weakly crenulate, last segment no wider than preceding segments. Tibial spines on fore and middle legs equally produced. Strigilis with apex of velum truncate, apex of malus produced into a very long (longest in subgenus), sharp spine, which projects slightly downward. Segments of mediotarsus of fore leg slightly swollen; second tarsal segment as wide as long, three and four progressively shorter, narrower; basitarsus four times longer than wide. Middle leg with coxa unmodified; mediotarsal segments not swollen, longer than wide. Hind basitarsus gradually increased to just before apex, which is semicircular; hind tibial spurs long, slender, apical half strongly curved. Papillae on apex of fore wing fine, thick; hair in cells short, sparse. Propodeal triangle reticulate, dull. Metasomal terga: Apical impunctate bands of terga two to five at least one-third as wide as punctate portions, weakly lined, shining; sixth tergum with apical fourth turned up, surface smooth, mid-apex scarcely emarginate; seventh with mid-apical emargination of produced portion rather deep, on each side the tooth is as wide as emargination. Metasomal sterna: First with a shallow, mid-apical, V-shaped notch; second with mid-apical process laterally compressed, extending well beyond margin of sternum, ventral surface of compressed portion white, as viewed laterally the projection is spatulate, median ventral groove extending from base of projection to just before base of sternum, the apical margin of which is laterally fringed with long black hairs; third with mid-apical concavity shallow, narrow, fringed with moderately long, golden hair which continues anteriorly as a median ventral stripe, margin of sternum on each side of concavity fringed with subapical, long, black hairs; fourth with median third produced apically, almost truncate, median apical patch of bristlelike hairs bent mesad at tips, surrounding an impunctate portion which is two times wider from middle to apex as at base (much larger than in *nifoata*), (Plate XLI, fig. 6); fifth with a broad, deep, U-shaped, mid-apical emargination which laterally is fringed with light golden hairs, medially by black and gold mixed; sixth with apex of mid-apical produced portion broadly and shallowly concave, forming to each side a divergent tooth, V-shaped carina anterior to apex absent (Plate XLII, fig. 8). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 10 and Plate XLIV, fig. 11.

Distribution: From British Columbia to Alberta, southward through Wyoming to the Rocky Mountain regions of Utah. The specimens studied are: *British Columbia:* Invermere, May 19, 1915

(F. W. L. Sladen); *Alberta:* Banff, July 13, 1938 (E. C. Van Dyke); *Wyoming:* Yellowstone National Park, July 21, 1920; Roosevelt Lodge, Yellowstone Park (E. C. Van Dyke); Jenny's Lake, Grand Tetons, June, 1941 (G. E. Bohart); *Utah:* Uinta National Forest, June 16, 1917 (J. Silver).

The type specimen is located in the Canadian National Collection, Ottawa.

Osmia unca Michener

(Plate XL, fig. 18; Plate XLI, fig. 3; Plate XLII, fig. 3; Plate XLIII, fig. 1, 2; Plate XLIV, fig. 4)

Osmia uncinata Michener, 1936, Canadian Ent., vol. 68, p. 39 (male); Michener, 1936, American Mus. Novitates, no. 875, p. 28 (key).
Osmia unca Michener, 1936, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 406 (proposed for *uncinata* Michener, not Gerstaecker, 1869); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 52; Michener, 1949, Jour. Kansas Ent. Soc., vol. 22, p. 55.
Osmia hicksi Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 53.
Osmia depressa Michener, 1936, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 406 (new synonymy); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 55.

This species resembles *O. nigrobarbata* Cockerell because of the uncinate process on the second metasomal sternum, also because of the mid-apical projection on the fourth metasomal sternum. It is distinguished from that species easily by the acute superior apical angle on the truncate upper mandibular tooth, and by the more weakly uncinate process (uncination usually occurs subapically in *unca,* and is always apical in *nigrobarbata*). From the other species in this subgenus *unca* can readily be separated by the spinelike process on the fourth metasomal sternum plus the uncinate process on second.

As pointed out by Michener (1949), *unca* was incorrectly placed in synonymy with *nigrobarbata* by Sandhouse (1939) and actually is the same as *O. hicksi* Sandhouse. *O. depressa* was incorrectly placed in the synonymy of *nifoata* by Sandhouse. Thanks to Dr. T. O. Thatcher of Colorado State College it has been possible to study the type of *depressa,* and it seems probable that it is *unca,* although it differs slightly in the uncinate part of the process on the second metasomal sternum. The uncination is not as wide as in typical *unca.*

Male: Length of body, 8½ to 10 mm.; fore wing 5½ to 7 mm.

Mandible dark brown to black, metallic at base; flagellum usually dark above, light below; legs dark brown except metallic femora. Body color varies: Genae, sides of thorax, metasomal terga, blue, elsewhere dark olive green; genae, sides of thorax, sides of abdo-

men, blue, elsewhere olive green; vertex of head olive green, elsewhere dark blue. Hair: On metasomal terga three to five black and white mixed; on lower surfaces of all tarsal segments reddish brown; elsewhere white, including fringe of hair on posterior surface of fore leg from coxa to last mediotarsal segment, fringes of long hair on posterior surface of middle femur, and fringes of hair over apical impunctate bands of metasomal terga three to five.

Mandible with narrow, rather shallow, V-shaped notch separating upper tooth from long, slender, lower tooth; apical edge above notch truncate, weakly convex below, produced above forming an acute superior apical angle; mandibular carinae parallel, subequal in width and height, space between them narrow (Plate XL, fig. 18). Trophi: Length of first segment of labial palpus is to second as 7.0:7.1; relative lengths of segments of maxillary palpus from base to apex as 8:12:15:7:5. Clypeus convex, apex unmodified; punctures on clypeus same as areas immediately surrounding, finer than those on rest of face; apical impunctate band one fifth as wide medially as greatest width of scape; postocellar and ocellocular lines equal, ocelloccipital slightly shorter; hypostomal carina moderately high, gradually increased anteriorly to highest point just behind angle (almost evenly raised). Flagellum crenulate (not so strongly as in *nigrobarbata*). Last segment no wider than preceding segments. Tibial spine on middle leg slightly longer than that on fore leg. Strigilis with apex of velum truncate, apex of malus produced into a very short, downward projecting spine. Segments of mediotarsus of fore leg weakly swollen; second tarsal segment as wide as long, three and four progressively narrower and shorter; basitarsus three times longer than wide. Middle leg with coxa unmodified; mediotarsal segments not swollen, longer than wide. Hind basitarsus with inferior apical angle almost a right angle, superior apical angle rounded, widest at apex; hind tibial spurs long, slender, curved only at tips. Papillae on apex of fore wing fine, thick; hair in cells short, dense. Propodeal triangle usually dull, more coarsely reticulate above (in some specimens finely lined, shining below). Metasomal terga: apical impunctate bands of terga two to five at least one third as wide as punctate portions, weakly lined, shining; sixth tergum with fold absent, apical margin convex; seventh with mid-apical emargination of produced portion wide, rather shallow, on each side the tooth is as wide as emargination. Metasomal sterna: First with a mid-apical V-shaped notch, apical margin fringed with white hairs; second with a mid-apical uncinate projection appearing as a con-

tinuation of margin of sternum, curved portion of process one third as long as width of sternum, which is acuminate in outline, fringed with long white hairs, ventral surface posterior to projection with a small, circular concavity; third with mid-apex slightly concave, concavity covered by short, golden, subapical hairs; fourth with median apical third produced (more strongly than in *nigrobarbata*), its mid-apex produced into a rather long, triangular, sharp spine (not as long as in *nigrobarbata*), median apical patch of bristlelike hairs bent mesad at tips, surrounding a subrectangular impunctate portion which extends to apex of sternum where it is widest, lateral hairs sparse, scattered (no definite lateral patches, much thinner than in *nigrobarbata*, Plate XLI, fig. 3); fifth with a broad, shallow, apical concavity which is thinly fringed with fine, light colored hairs; sixth with mid-apical produced portion rather wide, almost truncate, anterior to apex is a V-shaped carina (Plate XLII, fig. 3). Eighth sternum and gonocoxite as shown in Plate XLIII, figs. 1, 2, and Plate XLIV, fig. 4.

Distribution: From Oregon to British Columbia, southeastward along the Rocky Mountains to Colorado and Utah. The following list includes all of the twenty-three specimens studied: *Oregon:* Eagle Ridge, Klamath Lake, May 27, 1924 (C. L. Fox); Hermiston, May 4, 1927 (H. A. Scullen); *Washington:* Pullman, May 7, 1915; *British Columbia:* Osoyoos, June 10, 1919, paratype of *hicksi* (E. R. Bucknell); Penticton, June 5, 1929 (E. R. Bucknell); Vernon, May 15, 1923 (D. G. Gillespie); *Montana:* Helena, paratype of *hicksi*, July 7, 1907; *Colorado:* Boulder County, July 12, 1925 (C. P. Custer), May 2, 1925 (C. H. Hicks); Hygiene, May 23, 1936 (U. Lanham); Los Pinos, May, 1899 (C. F. Baker); Manitou, June 19, 1926 (E. C. Van Dyke); Colorado Springs, May 25, 1934, type specimen of *depressa; Utah:* Zion National Park, May 6, 1948 (G. E. Bohart).

The type specimen of *unca* has not been located, that of *hicksi* is in the United States National Museum; that of *depressa* is in the Colorado State College collection at Fort Collins.

Osmia odontogaster Cockerell

(Plate XL, fig. 15; Plate XLI, fig. 2; Plate XLII, fig. 5; Plate XLIII, fig. 5; Plate XLIV, figs. 2, 7)

Osmia odontogaster Cockerell, 1897, Proc. Acad. Nat. Sci. Philadelphia, vol. 49, p. 338 (male); Friese, 1911, Das Tierreich, Lief. 28, p. 156 (male); Criddle, Curran, Viereck, and Buckell, 1924, Rept. Ent. Soc. Ontario, vol. 33, p. 99 (record); Sandhouse, 1925, Canadian Ent., vol. 57, pp. 35, 63 (key, record); Michener, 1936, American Mus. Novitates, no. 875, p. 28 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 43.

Acanthosmiodes odontogaster Ashmead, 1899, Trans. American Ent. Soc., vol. 26, p. 76.

This species is very close to *O. obliqua,* but is distinguished by the truncate upper mandibular tooth and the acute superior apical angle, also by the shorter hind tibial spurs as compared in length to the hind basitarsus. It is easily separated from the other species in this subgenus by the produced inferior apical angle of the hind basitarsus.

Male: Length of body, 9 to 11 mm.; fore wing, 6½ to 7 mm.

Mandible dark brown to reddish brown; flagellum dark above, light below; legs dark brown with upper surfaces of femora and tibiae of more deeply colored specimens metallic. Body color varies: Head, thorax, propodeum, abdomen greenish blue; head, thorax, propodeum, greenish blue, abdomen light olive-green; or head, thorax, propodeum, abdomen, olive green with a golden tint. Hair: On vertex of head, dorsum of thorax, metasomal terga, from white to tawny; on lower surfaces of all tarsal segments reddish brown; posterior edges of middle basitarsus fringed with reddish brown hair; elsewhere white (rarely with a few black hairs scattered on the metasomal terga) with the following features: posterior surface of foreleg fringed with white hairs from coxa to last mediotarsal segment; posterior edges of femur and tibia of middle leg fringed with white hairs, longest hairs on tibia being twice as long as those on femur; fringes of white hairs extending over apical impunctate bands of metasomal terga.

Mandible with deep, V-shaped notch separating upper tooth from long, slender, lower tooth; apical edge above notch truncate (transverse) and from slightly concave to convex medially, superior apical angle acute (in some specimens almost a right angle); mandibular carinae parallel, equal in width and about equally raised, space between them narrow (Plate XL, fig. 15). Trophi: Length of first segment of labial palpus is to second as 7.0:7.1; relative lengths of segments of maxillary palpus from base to apex as 8:11:18:9:4. Clypeus convex, apex unmodified; punctations much finer than those on rest of face; apical impunctate band one third as wide medially as greatest width of scape. Ocellocular and postocellar lines subequal, ocelloccipital hardly shorter. Hypostomal carina very low, uniform. Flagellum weakly crenulate, last segment no wider than preceding segments. Tibial spine on middle leg about one third longer than that on foreleg. Strigilis with apex of velum subtruncate, inner apical angle strongly convex, apex of malus produced into a rather long, sharp, downward curving spine (ap-

parently not different from that of *obliqua*). Segments of mediotarsus of foreleg slightly swollen; fourth tarsal segment three fourths as wide as second, which is as wide as basitarsus; basitarsus evenly widened, one third as wide as long. Middle leg with coxa unmodified; tarsal segments not swollen, longer than wide. Hind basitarsus widest at apex, inferior apical angle produced, making an acute angle (not as strongly produced as in *obliqua* but always forming an acute angle); hind tibial spurs slender, curved only slightly at tips, the inner spur about two thirds as long as hind basitarsus (not over two thirds as long as basitarsus). Papillae on apex of forewing fine, dense; hair in cells short, sparse. Propodeal triangle dull, reticulate. Metasomal terga: Apical impunctate bands of terga one to five about one fourth as wide as punctate portions; bands one to three finely lined, shining, four and five checkered and dull; sixth tergum with apical one fourth slightly turned up, surface smooth, mid-apex barely concave; seventh with mid-apical emargination of produced portion wide, deep, U-shaped, on each side the tooth is narrow, about one half as wide as emargination. Metasomal sterna: First as in *obliqua;* second with a shallow concavity on mid-ventral surface immediately posterior to which apex is produced as a digitiform projection extending beyond apical margin of sternum with a median ventral groove causing the truncate apex to be emarginate, as viewed laterally the ventral and dorsal surfaces almost parallel, distance from widest basal portion to apex about one third the length of hind basitarsus, margin of sternum each side of projection fringed with long, white hair; third as in *obliqua* except for shallower mid-apical concavity; fourth with median apical third strongly produced, apex nearly truncate, median apical patch of bristlelike hairs bent mesad at tips, surrounding an impunctate portion which extends to apex where it is three times wider than at base, lateral patches very sparse, of short, brown, slender hairs (Plate XLI, fig. 2); fifth as in *obliqua;* sixth as in *obliqua,* but V-shaped carina anterior to apical emargination stronger (Plate XLII, fig. 5). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 5, and Plate XLIV, figs. 2, 7.

Distribution: The west coast from California to British Columbia. From the twenty-three specimens studied the following are selected localities: *California:* Mariposa County, June 4, 1942 (E. G. Linsley); Buck's Lake, Plumas County, June 23, 1949 (J. W. MacSwain); Shasta Springs, Shasta County, June 16, 1920; *Oregon:* Klamath Falls, May 10, 1924 (C. L. Fox); Eugene, May 29, 1936 (O. H. Sweezey); Yoncalla, May 27, 1937 (G. E. Bohart); Corvallis, May

17, 1910 (J. C. Bridwell) and April 15, 1926 (H. A. Scullen); Hood River, June 12, 1920 (E. C. Van Dyke); *Washington:* Olympia, May 28, 1894; Pullman, June 1921 (J. A. Lowry); *British Columbia:* Victoria, May 6, 1917 (A. E. Cameron), May 6, 1919 (W. Downes) and April 6, 1916 (R. C. Treherne); Saanich, May 8, 1914 (T. Wilson).

The type specimen is in the United States National Museum.

Osmia physariae Cockerell

(Plate XL, figs. 1, 16; Plate XLI, fig. 4; Plate XLII, fig. 1; Plate XLIII, fig. 4; Plate XLIV, fig. 6)

Osmia physariae Cockerell, 1907, Ann. Mag. Nat. Hist., ser. 7, vol. 20, p. 446 (male); Sandhouse, 1925, Canadian Ent., vol. 57, p. 35, 15 (key, record); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 117 (key); Michener, 1936, American Mus. Novitates, no. 875, p. 26; Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 54 (male); Michener, 1949, Jour. Kansas Ent. Soc., vol. 22, p. 56.

Osmia pinorum Cockerell, 1935, American Mus. Novitates, no. 766, p. 4 (female); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 61. (new synonymy)

Osmia erecta Michener, 1936, Canadian Ent., vol. 68, p. 40 (male); Michener, 1936, American Mus. Novitates, no. 875, p. 28 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 55.

Osmia crenulaticornis Michener, 1936, Bull. So. California Acad. Sci., vol. 35, p. 84 (male); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 49; Michener, 1949, Jour. Kansas Ent. Soc., vol. 22, p. 55. (new synonymy)

This species is close to *O. odontogaster* Cockerell, *O. unca* Michener, and *O. nifoata* Cockerell. It is rather easily separated from *odontogaster* by the less produced, rounded, inferior apical angle of the hind basitarsus; from *unca* and *nifoata* by the slender process on the second metasomal sternum, this process being carinate beneath and not uncinate. It is distinguished from all three of the above species by the absence of any concavity or depression on the ventral surface of the second metasomal sternum. The females of this species resemble those of *nifoata* very closely but are separated from that species by the more slender hind tibial spurs. There is considerable variation in a long series of this species; usually Southern Californian specimens are dark, becoming lighter toward the north, but both light and dark forms can be found at both extremes of the series. This is the first association of sexes for the species and is based on the wide distribution of both, plus their collection from the same locality, on the same date, by the same collector. The species *odontogaster* and *nifoata* have been pointed out above as being very close to this species and it is possible that the female belongs to one of them, but neither of those males are taken in as wide a range as *physariae* and the female placed here.

The name *erecta* was erroneously placed in synonymy of *nifoata* by Sandhouse (1939), who also tentatively placed *crenulaticornis* in synonymy with *enixa*, a species here excluded from the subgenus. *O. pinorum* was placed by Sandhouse in the synonymy of *melanopleura*, another species excluded from the subgenus.

Male: Length of body, 7 to 9½ mm.; fore wing 5 to 6 mm.

Mandible reddish brown, metallic at base; flagellum darker above than below; legs brown except metallic femora. Vertex of head, dorsum of thorax, olive green; elsewhere dark blue. Hair: On lower surfaces of all tarsal segments reddish brown; elsewhere white with the following features: posterior surface of fore leg fringed with white hair extending from coxa to last mediotarsal segment; fringes of short white hair extending over apical impunctate bands of third and fourth metasomal terga, extending well beyond apical margin of tergum on fifth.

Mandible with a rather wide, shallow, V-shaped notch separating upper tooth from long, slender, lower tooth; apical edge above notch truncate, superior apical angle slightly produced forming an acute angle; mandibular carinae parallel, upper being twice as wide as lower, space between them very narrow (Plate XL, fig. 16). Trophi: Length of first segment of labial palpus is to second as 5.2:6.0; relative lengths of segments of maxillary palpus from base to apex as 8:9:19:8:5. Clypeus convex, apex unmodified; punctures on clypeus same as those on rest of face to just above antennal bases, where they are coarser; apical impunctate band about one third as wide medially as greatest width of scape. Postocellar and ocellocular lines equal, ocelloccipital shorter. Hypostomal carina moderately high, uniformly raised (lower than in *unca*). Flagellum crenulate (not as strongly as in *nigrobarbata*), last segment no wider than preceding segments. Tibial spines on fore and middle legs subequal. Strigilis with apex of velum strongly convex, apex of malus produced into a short, stout, downward projecting spine. Segments of mediotarsus of fore leg very weakly swollen; second tarsal segment one third longer than wide, third and fourth progressively narrower and shorter; basitarsus three times longer than wide. Middle leg with coxa unmodified; mediotarsal segments not swollen, longer than wide. Hind basitarsus nearly uniformly widened, narrower at base, widest in middle, apex rounded; hind tibial spurs long, slender, curved only at tips. Papillae on apex of fore wing fine, sparse; hair in cells short, sparse. Propodeal triangle reticulate, dull. Metasomal terga: Apical impunctate bands of terga one to

five at least one third as wide as punctate portions, weakly lined, shining; sixth tergum with apical fourth turned up, surface smooth, mid-apex weakly notched; seventh varies, but usually with mid-apical emargination of produced portion wide, rather deep, U-shaped, on each side the tooth is wider than the emargination (in some specimens the emargination is shallow, tooth as wide as emargination). Metasomal sterna: First with apical margin convex; second with mid-apical process varying but usually extending beyond margin of sternum, ventral surface of process with a low median carina basally, apically almost keellike, laterally almost rectangular in outline, ventral surface of sternum anterior to process flat, its apex fringed with long white hairs (in some specimens the process is shorter and more weakly carinate, not keellike); third with mid-apical concavity shallow, filled by fringe of white hairs, subapical fringe of sternum thin; fourth with median-apical third weakly produced, its apex broadly rounded, median apical patch of brown, bristlelike hairs surrounding an ovate impunctate portion which extends to apex of sternum, hairs at apex straight, extending beyond margin of sternum, others bent mesad at tips, lateral hairs of sternum not in patches, thin, blending with median apical patch (Plate XLI, fig. 4); fifth with a broad, shallow apical concavity fringed with rather long apical and subapical hairs; sixth with mid-apical produced portion truncate, emargination and V-shaped carina absent (Plate XLII, fig. 1). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 4, and Plate XLIV, fig. 6.

Female: Length of body, 8 to 9 mm.; fore wing, 6½ to 7 mm.

From entirely dark blue to entirely dark olive green, but usually with vertex of head, dorsum of thorax, light olive green and metasomal terga dark olive green, elsewhere, including sides of abdomen, dark blue; ventral body surfaces, except metasomal sterna, nonmetallic, black to brown. Legs black to brown, except apical metallic patch on posterior surface of fore femur. Hair: Constant features are: on dorsum of thorax black and white mixed; on first metasomal tergum, except thin lateral patches, white; on upper surface of fore tarsus golden and on lower surfaces of all tarsi fulvous; on clypeus, genae, rest of legs, scopa, black; apices of femora fringed with white hair. Variable features: Hair on face (except clypeus), vertex of head, propodeum, from black to black and white mixed; fringes of hair extending over apical impunctate bands of third to fifth metasomal terga dusky to white.

Mandible with superior apical angle acute; no lower truncation on triangular upper tooth, which is equal in length to triangular

middle tooth, the two being separated by a wide, deep, V-shaped notch, lower margin of which is slightly concave; lower tooth long (almost twice as long as middle), slender, separated from middle tooth by a shallow, narrow, V-shaped notch; mandibular carinae parallel, equal in width, upper about two times higher medially than lower, space between them narrow; apex of mandible two times wider than constriction (Plate XL, fig. 1). Trophi: Length of first segment of labial palpus is to second as 6.2:7.0; relative lengths of segments of maxillary palpus from base to apex as 10:11:14:10:5. Clypeus rather strongly convex; punctures of clypeus finer apically, basally equal to those on rest of face; apical impunctate band five sixths as wide medially as greatest width of scape, band has transverse furrow present. Postocellar and ocellocular lines subequal, ocelloccipital longer. First segment of flagellum one and one-third times longer than pedicel. Hypostomal carina low, gradually increased from posterior limits to angle; hypostomal area in general convex, punctures rather coarse. Tibial spine on foreleg slightly longer than on middle leg. Longest hairs on fore basitarsus eight ninths as long as the basitarsus. Strigilis with apex obliquely acute to acuminate, spine long, sharp, inner apical angle more nearly an obtuse angle than rounded. Hind tibial spurs long, slender, usually straight (some specimens have the inner one bent slightly upward in the middle). Papillae on apex of fore wing fine, dense; hair in cells short, dense. Mesoscutum shining, punctures contiguous, coarser and much finer than fine, shallow punctures of metasomal terga. Propodeal triangle dull and reticulate above, polished below. Apical impunctate bands of metasomal terga two to five, one half as wide as punctate portions, absent on tergum one; bands on two and three finely checkered, shining, on four and five heavily checkered, shining to dull.

Distribution: This species has the most widespead range of any species in the subgenus, occurring from the southern California mountains to British Columbia, eastward to Saskatchewan, southward through the Rocky Mountain range to Colorado and Utah. One male and one female have been taken in Nevada. The following are selected localities from the one hundred eighty-nine specimens studied: *California:* Los Angeles County (Coquillett); Big Pine, San Bernardino County, July 2 (Cockerell, type of *pinorum*); Tetleys Mountain Camp, San Bernardino Mountains, on *Lotus,* May 16 (C. D. Michener); Inyo County, July 8, 1934 (G. E. Bohart); Jamesburg, Monterey County, June 7, 1938 (C. D. Michener); Hamilton, Santa Clara County, June 2, 1937 (G. E. Bohart);

Rock City, Mount Diablo, Contra Costa County, May 24, 1940 (E. G. Linsley); Carrville, Trinity County, June 2, 1934; Crabtree Meadow, Tulare County, July 20, 1935 (Evans, type of *crenulaticornis*); Huntington Lake, Fresno County, July 8, 1919 (E. P. Van Duzee); Gull Lake, Mono County, July 11, 1934; Rock Creek, Mono County, on *Iris*, June 23, 1937 (C. D. Michener); Columbia, Tuolumne County, August, 1917; Summit of Sonora Pass, June 26, 1937 (E. C. Van Dyke); Hope Valley, Alpine County, July 9, 1948 (J. W. MacSwain); Angora Peak, near Lake Tahoe, July 7, 1926 (E. P. Van Duzee); Truckee, Nevada County, July 4, 1927 (E. P. Van Duzee); Gold Lake, Sierra County, July 20, 1921 (C. L. Fox); Quincy, Plumas County, June 24, 1949 (P. D. Hurd); Buck's Lake, Plumas County, July 1, 1949 (P. D. Hurd); Mount Lassen, July 14, 1934 (E. P. Van Duzee); Davis Creek, Modoc County, July 15, 1922 (C. L. Fox); Big Flat, Siskiyou County, August 4, 1931 (R. L. Usinger); *Oregon:* Crater Lake, July 13, 1934 (E. C. Van Dyke); Klamath Lake, June 26, 1937 (Bolinger); Diamond Lake, Douglas County, July 16, 1934 (E. C. Van Dyke); Burns, Harney County, June 4, 1938 (E. C. Van Dyke); Three Sisters, Crook County, July 30, 1937 (Hansens); Buck Mountain, Benton County, July 9, 1906; Corvallis, Benton County, on *Trifolium hybridum*, June 8, 1909 (J. C. Bridwell); Blue Mountains, Grant County, on *Allium*, August 4, 1929; Hermiston, Umatilla County, May 30, 1924; Mount Hood, Hood River County, July 25, 1937 (E. C. Van Dyke); *Washington:* Walla Walla, June 10, 1939 (G. E. Bohart); Lind, May 23, 1919 (F. W. Carlson); Whitman County, July 1, 1936 (I. McCracken); White Rock Spring, July 14, 1930 (E. C. Van Dyke); Colfax, July 9, 1923 (C. L. Fox); Olympia, June, 1895; Pullman, July 9 (C. V. Piper); Hell's Crossing Forest Camp, Yakima County, July 27, 1936 (E. C. Van Dyke); *British Columbia:* Royal Oak, May 20, 1917 (R. C. Treherne); Oliver, June 3, 1923 (C. B. D. Garrett); Nelson, June 7, 1927 (A. A. Dennys); *Alberta:* Banff, July 13, 1938 (E. C. Van Dyke); Calgary, May 20, 1923; *Saskatchewan:* Indian Head, May, 1915 (F. W. L. Sladen); *Montana:* Gallatin County, June 9, 1904 (A. D. Hastings); Gallatin Canyon, Gallatin County, June 19, 1937 (F. W. Pennell); Bozeman, July 8, 1913; Missoula, June 22, 1904; *Wyoming:* Jackson, July 13, 1920; Jenny Lake, June 25, 1936 (G. E. Bohart); Roosevelt Lodge, Yellowstone, July 1, 1938 (E. C. Van Dyke); Orin, June 21, 1932 (H. G. Rodeck); Burnt Fork, June, 1926 (Hayward); *Idaho:* Potlatch, Latah County, June 25, 1936 (I. McCracken); Moscow, June 6, 1912 (J. M. Aldrich); Troy,

June 14, 1908; *Colorado:* Parker, May 26, 1934 (Figgins); Longmont, July 6, 1937 (U. Lanham); Camp Creek Ranger Station, June 19, 1920; Cederedge, July 11, 1938 (U. Lanham); *Utah:* Tony Grove Lake, Cache County, July 4, 1938 (G. E. Bohart); *Nevada:* Carson City, July 10, 1934 (E. P. Van Duzee); Ormsby County, July (Baker).

The type specimen of *physariae* is located in the United States National Museum; that of *crenulaticornis* in the Snow Entomological Collection at the University of Kansas; that of *pinorum* in the American Museum of Natural History; the location of the type of *erecta* is at the present time unknown.

Osmia nifoata Cockerell

(Plate XXXIX, fig. 9; Plate XL, fig. 17; Plate XLI, fig. 1; Plate XLII, fig. 4; Plate XLIII, fig. 3; Plate XLIV, fig. 8)

Osmia nifoata Cockerell, 1909, Entom., vol. 42, p. 95 (male); Sandhouse, 1924, Proc. California Acad. Sci., ser. 4, vol. 13, p. 357, 370 (key, record); Sandhouse, 1925, Canadian Ent., vol. 57, pp. 35, 63 (key, record); Cockerell, 1934, American Mus. Novitates, no. 697, p. 14 (record); Michener, 1936, American Mus. Novitates, no. 875, p. 26; Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 55; Michener, 1949, Jour. Kansas Ent. Soc., vol. 22, p. 56.

Osmia wyomingensis Michener, 1936, American Mus. Novitates, no. 875, p. 27 (male); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 48.

Osmia pellax Sandhouse, 1924, Proc. California Acad. Sci., ser. 4, vol. 13, p. 356 (female); Michener, 1936, American Mus. Novitates, no. 875, p. 26 (record); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 63. (New synonymy.)

This is the most variable species, among the males, of any in this subgenus. The male resembles very closely that of both *O. odontogaster* and *O. obliqua* but is distinguished by the less produced inferior apical angles of the hind basitarsi. It also resembles *O. physariae,* but the process on the second metasomal sternum is more swollen and never ventrally carinate as is usually the case in that species. Sandhouse incorrectly placed *O. sladeni, O. erecta,* and *O. depressa* as synonyms of this species. Michener (1949) points out that *erecta* is placed correctly under *physariae.* The species *sladeni* is distinct, and separated from *nifoata* by its laterally compressed process on the second metasomal sternum; *depressa* is shown to be synomymous with *O. unca* by the uncinate process on the second metasomal sternum, also by the sharp, spinelike, midapical projection on the fourth metasomal sternum. The females resemble very closely those of *O. physariae,* but are distinguished by the thicker hind tibial spurs. This is the first association of sexes for the species and is based on collection data mainly, especially so since so far there has been no structural characteristic found in

the genus which would enable one to link the sexes. Dr. Michener has taken males and females of the species together (not copulating) in the San Jacinto Mountains on the same date and same species of flower. There is little doubt that *pinorum* and *pellax* are the females of *physariae* and *nifoata* respectively, but since the two males are so close it is possible that the relationship here expressed has been reversed from the true situation.

Among the specimens studied are two paratypes of *pellax* and two specimens kindly compared with the type specimen of that species by Dr. E. S. Ross.

Male: Length of body, 7 to 10 mm.; fore wing 5½ to 6½ mm.

Mandibles dark brown to black, metallic at bases; flagellum entirely brown to darker above than below; legs dark brown except metallic fore femora (some specimens have all femora metallic, a few have metallic patches on bases of tibiae). Head, thorax, propodeum, greenish blue; abdomen dark blue (in some specimens completely olive green as in *odontogaster*). Hair: Extremely variable, constant features are: on face, vertex of head, dorsum of thorax, white; on fourth and fifth metasomal terga (some specimens with a few scattered, pale hairs extending over apical impunctate bands) and metasomal sterna except golden hair on apex of third, black; on lower surfaces of all tarsal segments reddish brown; on rest of head, rest of thorax, metasomal terga two and three, black and white mixed (more white hairs on head and thorax, more black hairs on terga). Variable features of the pubescence are: on propodeum, first metasomal tergum, from entirely white to white with lateral black patches; fringe of hairs on posterior surface of foreleg from coxa to last mediotarsal segment from entirely white to mixed.

Mandible with a rather wide, shallow V-shaped notch separating upper tooth from long, slender, lower tooth; apical edge above notch transverse to convex, superior apical angle produced, forming an acute angle; mandibular carinae parallel, upper carina wider than lower, space between them narrow (Plate XL, fig. 17). Trophi: Length of first segment of labial palpus is to second as 5.2:6.2; relative lengths of segments of maxillary palpus from base to apex as 7:11:11:9:6. Clypeus strongly convex, apex unmodified; punctures on clypeus same as areas immediately surrounding, finer than those on rest of face; apical impunctate band one fifth as wide medially as greatest width of scape. Postocellar and ocelloccipital lines subequal, ocellocular shorter. Hypostomal carina low, highest just behind angle. Flagellum weakly crenulate, last segment

no wider than preceding segments. Tibial spine on middle leg nearly twice as long as on fore leg. Strigilis with apex of velum convex, apex of malus produced into a long, stout, downward projecting spine. Segments of mediotarsus of foreleg very weakly swollen; second tarsal segment one third longer than wide, third shorter, fourth shorter and narrower; basitarsus four times longer than wide. Middle leg with coxa unmodified; mediotarsal segments not swollen, longer than wide. Hind basitarsus narrowest at base, gradually widened to rounded apex; hind tibial spurs rather long, slender, slightly curved. Papillae on apex of fore wing fine, thick; hair in cells short, sparse. Propodeal triangle finely lined, shining below, dull and reticulate above. Metasomal terga: Apical impunctate bands of terga two to five at least one third as wide as punctate portions, weakly lined, shining; sixth tergum with apical one fourth hardly folded, surface smooth, mid-apex practically not notched; seventh variable as in *physariae*, usually with mid-apical emargination shallow, on each side of which the tooth is wider than emargination. Metasomal sterna: First with a shallow, mid-apical, V-shaped notch, from which a narrow, shallow groove extends anteriorly on ventral surface of sternum; second similar to *odontogaster,* but mid-apical process varying more than in that species, process tumid, digitiform, with a median ventral groove in some specimens, as viewed laterally the base of process extends ventrally but abruptly turns posteriorly, ventral surface of sternum concave immediately anterior to base of projection; third with mid-apical concavity shallow, narrow, fringed with moderately long golden hairs, apical margin of sternum fringed with subapical, long, black hairs; fourth with median apical third produced, apex broadly rounded, median apical patch of bristlelike hairs bent mesad at tips, surrounding an impunctate portion which is narrow in basal two thirds, broadening rapidly to apex, apical bristles not extending across apex, lateral patches distinct, of straight, black hairs (Plate XLI, fig. 1); fifth with a broad, deep, U-shaped mid-apical emargination, thinly fringed with light colored hairs; sixth with a mid-apical produced portion, its apex with a broad, shallow V-shaped emargination, V-shaped carina anterior to apex absent (Plate XLII, fig. 4). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 3, and Plate XLIV, fig. 8.

Female: Length of body, 9½ to 10 mm.; fore wing 6½ to 7 mm.

Mesoscutum with a slight greenish tinge; elsewhere dark blue; ventral body surfaces except mesepisternum and metasomal sterna, non-metallic, black. Legs black except apical metallic patches on

posterior surfaces of fore and hind femora. Hair: On supra-antennal areas, vertex of head, dorsum of thorax, propodeum, black and white mixed; on metasomal terga white except thin lateral black patches; fore tarsus with golden brown hair; on lower surfaces of middle and hind tarsi reddish brown; apices of hind femora with light colored fringes of hairs; elsewhere black.

Mandible with superior apical angle acute; no lower truncation on triangular upper tooth which is equal in length to triangular middle tooth, the two being separated by a moderately wide, deep, V-shaped notch, lower tooth longer (one-third longer than middle), rather wide, separated from middle by a wide, V-shaped notch; mandibular carinae parallel, equally raised and equal in width, space between them narrow; apex of mandible two and one-fourth times wider than constriction (Plate XXXIX, fig. 9). Trophi: Length of first segment of labial palpus is to second as 17:20; relative lengths of segments of maxillary palpus from base to apex as 10:11:12:10:7. Clypeus strongly convex; punctures of clypeus equal to those on rest of face; apical impunctate band three eights as wide medially as greatest width of scape, band has a transverse furrow. Ocellocular and ocelloccipital lines subequal, postocellar one-fourth shorter. First segment of flagellum one and one-fourth times longer than pedicel. Hypostomal carina low, evenly raised; hypostomal area in general convex, punctures coarse. Tibial spine on foreleg equal in length to that on middle leg. Longest hairs on fore basitarsus three fifths as long as basitarsus. Strigilis with apex obliquely acute, spine short, blunt, inner apical angle more nearly an obtuse angle than rounded. Hind tibial spurs long but wide, being widest one third their total length from base (two times wider than at base), gradually reduced to slightly curved tips (these are the widest hind tibial spurs in the subgenus). Papillae on apex of forewing fine, dense; hair in cells short, dense. Mesoscutum shining, punctures confluent, coarser and much deeper than fine, shallow punctures of metasomal terga. Propodeal triangle dull, reticulate above, heavily lined but shining below. Apical impunctate bands of metasomal terga two to five nearly one half as wide as punctate portions, present on tergum one only as mid-apical impunctate triangle; band two, finely lined, shining, three, weakly checkered, shining, four and five heavily checkered, rather dull.

Distribution· The west coast from California to Washington, to Idaho and south through the Rocky Mountains to Colorado. The following are selected localities from the one-hundred twelve speci-

mens studied: *California:* Los Angeles County, June 1; Tetleys Park, San Bernardino Mountains, July, 1941 (E. C. Van Dyke); Santa Rosa Mountain, San Jacinto Mountains, on *Lotus davidsonii* and *Astragalus,* May 31, 1940 (C. D. Michener); Idyllwild, San Jacinto Mountains, June 19, 1940 (E. C. Van Dyke); Keen Camp, Riverside County, June 6-12 (E. P. Van Duzee, paratypes of *pellax*); Summit Sonora Pass, June, 1937 (E. C. Van Dyke); Huntington Lake, Fresno County, July 4, 1919 (E. P. Van Duzee); Inyo County, June, 1937 and Mono County, June, 1937 (C. D. Michener); Truckee, June, 1927 (E. P. Van Duzee); Buck's Lake, Plumas County, June, 1949 (J. W. MacSwain); Gold Lake, Sierra County, July, 1921 (C. L. Fox); Lake Tahoe, June, 1925 (E. B. Nast); Dead Man's Creek, Alpine County, June, 1937 (C. D. Michener); Placer County Summit (W. M. Giffard); Mount Lassen, August, 1938 (E. C. Van Dyke); *Oregon:* Lake County, May 25, 1913 (F. W. Nunenmacher); Fish Lake, Steen's Mountains, July, 1927 (H. A. Scullen); Homestead Inn, Mount Hood, July, 1927 (E. C. Van Dyke); Grant County, July, 1936 (H. A. Scullen); *Washington:* Pullman, June, 1904; Mount Adams, July 10, 1927 (M. W. Stone); *Idaho:* Cub River Canyon, June, 1898; *Wyoming:* Jackson's Hole, June, 1936; Foxpark, June, 1920; *Colorado:* Steamboat Springs, June 15, 1938 (R. Bauer); Troublesome, June, 1908 (S. A. Rohwer); Pagosa, June, 1935 (C. R. Rotger); *Utah:* Park City, July 1922 (E. P. Van Duzee); Logan, May, 1947 (M. Varzandeh).

The type specimen of *nifoata* is located in the United States National Museum; of *wyomingensis* in the American Museum of Natural History; and of *pellax* in the California Academy of Sciences.

Osmia sedula Sandhouse

(Plate II, fig. 6)

Osmia sedula Sandhouse, 1924, Proc. California Acad. Sci., ser. 4, vol. 13, p. 353 (female); Criddle, 1925, 55th Rept. Ent. Soc. Ontario, p. 103 (record); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 61 (female).
Osmia lutzi Michener, 1936, American Mus. Novitates, no. 875, p. 25 (female); Sandhouse, 1931, Mem. Ent. Soc. Washington, no. 1, p. 63. (new synonymy.)

This species resembles, somewhat, specimens of *O. titusi* Cockerell and *O. prunorum* Cockerell but is easily separated from both by the black scopal hair and by the fact that it is a much darker species with more black body hair. It can be distinguished from other species in the subgenus by a combination of the following characters: lower truncation on apex of upper mandibular tooth, punctures on metasomal terga extending almost to apices of terga, and the solidly black scopal hairs.

O. lutzi Michener was tentatively placed as a synonym of *O. pellax* Sandhouse by Sandhouse (1939) but examination of the type specimen showed *lutzi* to be an interesting record of *sedula* from Wyoming. Previously it had been recorded only from the Pacific coast states.

Female: Length of body, 8½ to 9 mm.; fore wing, 6 to 6½ mm.

Vertex of head, dorsum of thorax, propodeum, olive green; paraocular regions, sides of clypeus, blue; elsewhere dark olive green; ventral body surfaces, except hypostomal areas and metasomal sterna nonmetallic dark brown. Legs black to dark brown. Hair: On clypeus, legs except tarsi, scopa, black; on sides of thorax, propodeum, first metasomal tergum, white; on upper surface of fore tarsus dark brown and black mixed; on lower surface of fore tarsus, entire middle tarsus, lower surfaces of hind tarsus and tibia, reddish brown; apices of femora heavily fringed with short white hair; recumbent white hairs on sixth metasomal tergum give that structure a silvery appearance; elsewhere black and white mixed (on face, vertex of head, dorsum of thorax, white hair is predominant, long; on genae white hair is predominant, short; on metasomal terga two to five black hair is predominant, long, the white hair very short, except rather heavy fringes extending over apical impunctate bands).

Mandible with superior apical angle produced above lower truncation, forming an acute angle; outer surface of truncation concave, its apex from truncate to slightly oblique, separated from triangular middle tooth by a narrow, shallow, V-shaped notch; lower tooth longer (one fourth longer than middle), wider, separated from middle by a narrow, shallow, V-shaped notch; mandibular carinae parallel, upper carina about one-third higher medially than lower carina, the two being subequal in width, space between them narrow; apex of mandible two times wider than constriction (Plate XL, fig. 6). Trophi: Length of first segment of labial palpus is to second as 3.5:5.5; relative lengths of segments of maxillary palpus from base to apex as 9:10:15:11:8. Clypeus convex; punctures on clypeus apically equal to those between antennal bases, otherwise equal to those on rest of face; apical impunctate band one half as wide medially as greatest width of scape, band has a transverse furrow. Ocellocular and ocelloccipital lines subequal, postocellar shorter. First segment of flagellum one and one-third times longer than pedicel. Hypostomal carina high, highest well behind angle, rather rapidly reduced anteriorly; hypostomal area in general convex, lowest mesad, punctures rather fine. Tibial

spine on middle leg slightly wider, no longer, than on foreleg. Longest hairs on fore basitarsus subequal in length to basitarsus. Strigilis with apex obliquely acuminate, spine rather long, sharp, inner apical angle more angulate than rounded. Hind tibial spurs long, slender, slightly curved at tips. Papillae on apex of fore wing fine, dense; hair in cells short, moderately dense. Mesoscutum shining, punctures contiguous, subequal to but more dense than those on metasomal terga. Propodeal triangle dull, reticulate. Apical impunctate bands on metasomal terga very narrow if present, punctures extending almost to apical margins.

Distribution: Central California, one locality in the south-central part of British Columbia, and Jackson's Hole, Wyoming. The following list includes all of the localities of the fourteen specimens studied: *California:* El Paso Mountains, Kern County, May 26, 1949 (J. W. MacSwain); Atascadero, San Luis Obispo County, April 26, 1919 (E. P. Van Duzee); Santa Lucia Mountains, Jamesburg, Monterey County, May 19, 1938 (C. D. Michener); Arroyo Mocho, Livermore, May 6, 1948 (J. W. MacSwain); Snowline Camp, Eldorado County, June 27, 1948 (J. W. MacSwain); *British Columbia:* Penticton, June 7, 1919 (E. R. Buckell); *Wyoming:* Jackson's Hole, July 13, 1920 (type specimen of *lutzi*).

The type specimen of *sedula* is located in the California Academy of Sciences; of *lutzi* in the American Museum of Natural History.

Osmia trifoliama Sandhouse

(Plate XL, fig. 4)

Osmia trifoliama Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 44 (female).

This species is very distinct, closest to *O. francisconis* new species and *O. nigrobarbata* Cockerell, but easily distinguished by the flattened clypeus. The punctations on the clypeus are coarse and arising from the punctures are rather coarse, proclinate hairs. This is the only species in *Acanthosmioides* which has the flattened clypeus.

Female: Length of body, 8 to 9 mm.; fore wing 6 mm.

Head, sides of thorax, metasomal terga, dark olive green; clypeus darker than rest of head; dorsum of thorax greenish blue; ventral body surfaces nonmetallic, black. Legs black. Hair: On dorsum of thorax, lateral patches of hair on first metasomal tergum, fringes of short hairs on apices of femora, sparse fringes of hairs over apical impunctate bands of metasomal terga two to five, white; on vertex of head black and white mixed; on upper surface of fore tarsus golden; on lower surfaces of all tarsal segments reddish brown; fine,

recumbent, light colored hair of sixth metasomal tergum give that structure a silvery appearance; elsewhere black.

Mandible with superior apical angle produced above lower oblique to transverse truncate portion forming an acute angle; upper tooth shorter than triangular middle tooth, the lower margin of which is slightly convex and upper margin slightly concave, the two being separated by a narrow, rather deep, U-shaped notch; lower tooth long (three fourths longer than middle), wide, separated from middle by a narrow, deep, V-shaped notch; mandibular carinae parallel, upper carina about one-third higher medially than lower, the two subequal in width, space between them narrow; apex of mandible two times wider than constriction (Plate XL, fig. 4). Clypeus flattened (not convex); punctures on clypeus coarser than those on rest of face (proclinate hairs arising from punctures), apical impunctate band about one fourth as wide medially as greatest width of scape, band has a transverse furrow. Trophi: Length of first segment of labial palpus is to second as 5:6; relative lengths of maxillary palpus from base to apex as 10:10:11:7:5. Ocellocular, ocelloccipital, postocellar lines subequal. First segment of flagellum one and one half times longer than pedicel. Hypostomal carina low, highest just behind angle, rather rapidly reduced to angle; hypostomal area in general convex, punctures coarse. Tibial spines weakly and evenly produced on fore and middle legs. Longest hairs on fore basitarsus three fourths as long as basitarsus. Strigilis with apex obliquely acute to acuminate, spine short, sharp, inner apical angle broadly rounded. Hind tibial spurs long, slender, slightly curved at tips. Papillae on apex of forewing fine, thick; hairs in cells short, dense. Mesoscutum dull, punctures contiguous, coarser and deeper than fine, dense punctures on metasomal terga. Propodeal triangle from entirely dull and reticulate, to dull and reticulate above, polished below. Apical impunctate bands of metasomal terga two to five about one fourth as wide as punctate portions, on tergum one narrower; bands, two to five reticulate, dull, band one finely lined, shining.

Distribution: Known only from the Corvallis, Oregon region. The following is a selected list of the locality data taken from the thirty specimens studied: *Oregon:* Corvallis, June and July 1897, June 1898, June 1899, June and July 1909, on *Trifolium hybridum* and *T. pratense* (J. C. Bridwell); Rickreall, July 23, 1905 (Allen); Scappose, July 8, 1936 (R. E. Rieder); all of the above listed specimens are paratypes.

The type specimen is located in the United States National Museum.

Osmia francisconis new species

(Plate XL, fig. 2)

Osmia enixa Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 49 (female only).

This species resembles *O. nigrifrons* Cresson, *O. hurdi* new species, and *O. trifoliama* Sandhouse. The flattened hypostomal areas distinguish *nigrifrons;* the notch separating the upper mandibular tooth from the middle tooth distinguishes *hurdi;* and the flattened clypeus distinguishes *trifoliama.* A combination of the following characteristics will usually separate this species from other species in the subgenus: strigilis very similar to that of the males with the apex of the velum truncate and the apex of the malus produced into a long, slender, sharp spine (this will not hold true in all specimens); the superior apical angle produced above a lower, transverse truncation; the shallow, rather narrow, V-shaped notch separating the upper mandibular tooth from the middle tooth; and the white to tawny hair on the dorsum of the thorax (the black hair on the head, sides of thorax, and abdomen are outstanding as contrasted to the white hair on the dorsum of the thorax).

Sandhouse (1939) placed this species as the female of *O. enixa* Sandhouse, but the male of *enixa* is very plainly not a member of *Acanthosmioides;* there is no modification on the second metasomal sternum, the fourth metasomal sternum is not typical, and the mandible has two distinct mandibular teeth which are even in length and separated by a wide, deep, V-shaped notch. The male apparently belongs in *Nothosmia* and the female is here described as new.

Female: Length of body, 9½ mm. (varying to 10 mm. among paratypes); fore wing, 6½ mm. (varying to 7 mm. among paratypes).

Clypeus, sides of face, genae, sides of thorax, mesoscutellum, propodeum, dark blue; elsewhere greenish blue; ventral body surfaces black, nonmetallic. Legs dark brown. Hair: On dorsum of thorax tawny (varying to white among paratypes); fimbria of hairs over impunctate band of clypeus, hair on lower surfaces of all tarsal segments, dark brown to reddish brown; on first metasomal tergum except lateral black patches, white; elsewhere black.

Mandible with superior apical angle produced above lower transversely truncate portion (oblique among paratypes) forming an

acute angle; upper tooth much longer than triangular middle tooth, the lower margin of which is convex, separated from middle by a narrow, shallow, V-shaped notch; lower tooth nearly same length as middle, wide, separated from middle by a very narrow, deep, V-shaped notch; mandibular carinae parallel, equal in width and equally raised, space between them narrow; apex of mandible two and one-half times wider than constriction (Plate II, fig. 2). Trophi: Length of first segment of labial palpus is to second as 5:7; relative lengths of segments of maxillary palpus from base to apex as 9:11:12:10:6. Clypeus convex; punctures on clypeus apically equal to those between antennal bases, otherwise equal to those on rest of face; apical impunctate band one half as wide medially as greatest width of scape, band has transverse furrow. Postocellar and ocelloccipital lines equal, ocellocular one-fourth longer. First segment of flagellum one and one-half times longer than pedicel. Hypostomal carina low, highest well behind angle, rather rapidly reduced to angle; hypostomal area in general convex, punctures moderately fine. Tibial spine on middle leg longer and wider than that on foreleg. Longest hairs on fore basitarsus subequal in length to basitarsus. Strigilis with apex of velum truncate, inner apical angle a right angle, apex of malus produced into a very long, straight, sharp spine. Hind tibial spurs subequal in length, rather short, slightly curved at tips. Papillae on apex of fore wing fine, dense; hair in cells short, moderately dense. Mesoscutum dull, punctures contiguous, coarser, much deeper than fine, shallow punctures on metasomal terga. Propodeal triangle dull and reticulate above, polished below. Apical impunctate bands of metasomal terga two to five about one fourth as wide as punctate portions, on tergum one much narrower; band on two weakly lined, shining, bands on three to five checkered, rather dull.

Distribution: Known only from the area around San Francisco, California. Holotype, Sand Dunes, San Francisco, April 25, 1925 (C. L. Fox); one paratype Sand Dunes, San Fransciso, May 21, 1922 (C. L. Fox); two paratypes, San Francisco, May 5, 1912 (J. C. Thompson); one paratype, April 13, 1913 (J. C. Bridwell); one paratype, Oakland, May 26, 1915 (M. C. Van Duzee).

The holotype and one paratype will be returned to the California Academy of Sciences; two paratypes will be returned to the United States National Museum; and two paratypes are in the Snow Entomological Collections at the University of Kansas.

Osmia nigrifrons Cresson

(Plate XXXIX, figs. 5, 6)

Osmia nigrifrons Cresson, 1878, Trans. American Ent. Soc., vol. 7, p. 103 (female); Cockerell, 1897, Proc. Acad. Nat. Sci. Philadelphia, vol. 49, p. 347 (key); Fowler, 1902, Univ. California Agr. Expt. Sta.: 326 (record); Cockerell, 1903, Psyche, vol. 10, p. 76 (list); Viereck, 1903, Trans. American Ent. Soc., vol. 29, p. 47 (record); Cockerell, 1906, Trans. American Ent. Soc., vol. 32, p. 305 (record); Cockerell, 1906, Bull. American Mus. Nat. Hist., vol. 22, p. 447 (key); Cockerell, 1907, Ann. Mag. Nat. Hist., ser. 7, vol. 20, p. 449 (record); Cockerell, 1907, Univ. Colorado Studies, vol. 4, p. 251 (key); Cockerell, 1910, Canadian Ent., vol. 42, p. 311 (record); Friese, 1911, Das Tierreich, Lief. 28, p. 155; Cresson, 1916, Mem. American Ent. Soc., no. 1, p. 126 (record); Clements and Long, 1923, Expt. Pollination, Carnegie Inst. Washington Pub., no. 336, p. 253 (record); Sandhouse, 1924, Proc. California Acad. Sci., ser. 4, vol. 13, pp. 364, 367 (key, record); Sandhouse, 1925, Canadian Ent., vol. 57, pp. 40, 61 (key, record); Hicks, 1926, Univ. Colorado Studies, vol. 15, p. 246 (biology); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 123 (key); Beck, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 305 (record); Cockerell, 1934, American Mus. Novitates, no. 697, p. 14 (record); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 60 (female); Stevens, 1949, Bi-monthly Bull. North Dakota Agr. Expt. Sta., vol. 11, p. 211 (record).

Osmia casta Cockerell, 1910, Ent. News, vol. 21, p. 272 (female).

This species is close to *O. hurdi* new species, but is separated by the flattened and more finely punctate hypostomal areas and the shorter strigilar projection. Small specimens of *O. longula* Cresson may be confused with *nigrifrons* but the longer first flagellar segment in that species plus the flattened hypostomal areas in *nigrifrons* separate these. Variations of hair color are frequent and we notice that the more southern specimens usually have more dark hairs present. It is a dark species, with long body hair and a widespread range, apparently occurring throughout the range of *Acanthosmioides*, although I have not seen specimens from any of the Canadian Provinces. In material previously identified by Sandhouse I have found several specimens from British Columbia and Alberta, but they had apparently been misidentified. Most of the material from the Canadian National Museum bearing labels of this species were actually pale specimens of *longula* or *O. integra* Cresson.

Female: Length of body, 9½ to 12½ mm.; fore wing, 7 to 8 mm.

Vertex of head, dorsum of thorax (where there are large amounts of white hair), olive green; central portion of clypeus black; elsewhere dark blue, darkest on sides; ventral body surfaces, except mesepisternum and metasomal sternum two, nonmetallic, dark brown to black. Legs black. Hair: On dorsum of thorax, first metasomal tergum, white to black and white mixed; on face, vertex of head, propodeum, second metasomal tergum, entirely black to

black and white mixed; lower surfaces of all tarsal segments with golden brown hair; elsewhere black.

Mandible with superior apical angle acute, almost a right angle; no lower truncation on upper tooth which is shorter than nearly triangular middle tooth, the lower margin of which is strongly convex, the two being separated by a very wide, shallow, V-shaped notch (upper margin of notch much longer than lower margin); lower tooth long (two times longer than middle), slender, separated from middle by a wide, shallow, V-shaped notch; mandibular carinae parallel, upper carina about three times higher medially than lower, the two being equal in width, space between them moderately wide; apex of mandible two and one-half times wider than constriction (Plate XXXIX, figs. 5, 6). Trophi: Length of first segment of labial palpus is to second as 11:12; relative lengths of segments of maxillary palpus from base to apex as 12:12.5:15: 9:6. Clypeus convex; punctures on clypeus almost equal to those on rest of face; apical impunctate band two fifths as wide medially as greatest width of scape, band has transverse furrow. Ocellocular line slightly longer than ocelloccipital, postocellar one-fourth shorter. First segment of flagellum two times longer than pedicel. Hypostomal carina low, highest well behind angle where hypostomal area is slightly sunken, fading away posteriorly, gradually reduced forward; hypostomal area in general flattened, punctures very fine. Tibial spine on middle legs slenderer, about one third longer than that on foreleg. Longest hairs on fore basitarsus three fifths as long as basitarsus. Strigilis with apex obliquely acute, spine short, blunt, inner apical angle strongly convex. Hind tibial spurs long, slender, straight except for extreme tips which are curved. Papillae on apex of fore wing fine, dense; hair in cells short, thick. Mesoscutum shining, punctures contiguous, coarser, much deeper than shallow punctures on metasomal terga. Propodeal triangle entirely dull and reticulate. Apical impunctate bands of metasomal terga one to five not more than one sixth as wide as punctate portions; bands one and two polished, three finely lined and shining, four and five checkered and dull.

Distribution: Pacific Coast states eastward through Idaho, Montana, and Wyoming to North Dakota, Colorado and Utah. The following is a selected list of localities from the one-hundred twenty-four specimens studied: *California:* Stone Canyon, Monterey County, April 21, 1919 (E. P. Van Duzee); Concord, Contra Costa County, April 30, 1947 (G. E. Bohart); San Geronimo, Marin County, 1913; Cazadero, Sonoma County, April 12, 1918

(E. P. Van Duzee); Trinity County, April 18, 1918 (E. R. Leach); Eldorado County, June 21, 1948 (L. W. Quate); Summit Sonora Pass, on *Astragalus,* June 27, 1937 (C. D. Michener); Hope Valley, Alpine County, July 9, 1948 (P. D. Hurd); Truckee, June 20, 1927 (E. P. Van Duzee); Butte County, May 20, 1944 (E. C. Van Dyke); *Oregon:* Klamath Lake, May 24, 1924 (C. L. Fox); Frog Camp, July 19, 1927 (H. A. Scullen); Silver Creek, July 8, 1906; La Grand, May 11, 1930 (H. A. Scullen); Scappoose, June 24, 1936 (R. E. Reider); Steens Mountains, July 11, 1927 (H. A. Scullen); Corvallis, June 23, 1900 (J. C. Bridwell); Aneroid Lake, July 23, 1929 (H. A. Scullen); *Washington:* Pullman, May 20, 1901 and June 1, 1915 (A. L. Melander); *Idaho:* Franklin, June 1, 1948 (G. E. Bohart); *Montana:* Bozeman, June 24, 1901 (E. J. S. Moore); Gallatin County, July 10, 1917; Mystic Lake, July 24, 1902; *Wyoming:* Yellowstone Park, July 17, 1923; Jackson's Hole, on clover, June 20, 1936; *Colorado:* Boulder, April 28, 1913 (M. O. Ellis); Twin Sisters Mountain, June 19 (W. P. Cockerell); Science Lodge, Boulder County, June 22, 1939 (U. N. Lanham); Minnehaha, June 10, 1918; Oslar Mill Gulch, June 2; Paonia, June 15, 1927 (E. C. Van Dyke); *Utah:* Pangnitah, July 13, 1949 (G. F. Knowlton); Logan, on *Vicia,* June 16, 1947 (G. E. Bohart); Salt Lake (C. N. Ainslie).

The type specimen of *nigrifrons* is in the collection of the Academy of Natural Sciences at Philadelphia; of *casta* in the United States National Museum.

Osmia hurdi new species

(Plate XXXIX, fig. 7)

This species is close to *O. nigrifrons* Cresson, but distinguished by the much coarser punctures on the hypostomal areas which are convex in *hurdi* and flat in *nigrifrons.* Superficially it might be confused with *O. francisconis* new species but the truncation on the upper mandibular tooth in that species easily separates these two. The specimens studied show great variation in the amount of white hair on the dorsum of the thorax.

Female: Length of body, 10 mm. (varying to 12 mm. among paratypes); fore wing, 8 mm. (7½ to 8½ mm. among paratypes).

Vertex of head, supra-antennal areas, dorsum of thorax, propodeal triangle, light olive green (this color not extending to supra-antennal areas on some of paratypes); metasomal terga dark greenish blue (most of paratypes dark blue); elsewhere dark blue; ventral body surfaces, mesepisternum and metasomal sterna, nonmetallic, black. Legs black. Hair: On dorsum of thorax white (some paratypes

have few black hairs toward sides of dorsum); on vertex of head, supra-antennal areas, mixed; on first metasomal tergum white medially, on each side of which is a black patch of hair (some paratypes mixed); on fore tarsus golden brown; on lower surfaces of middle and hind tarsi dark brown; elsewhere black.

Mandible with superior apical angle almost a right angle; no lower truncation on upper tooth which is subequal in length to triangular middle tooth, the two being separated by a wide, shallow, V-shaped notch; lower tooth long (two times longer than middle), slender, separated from middle by a wide, shallow, V-shaped notch; mandibular carinae parallel, upper carina about two times higher medially than lower, the two being equal in width, space between them moderately wide; apex of mandible two and one fifth times wider than constriction (Plate XXXIX, fig. 7). Trophi: Length of first segment of labial palpus is to second as 7:8; relative lengths of segments of maxillary palpus from base to apex as 10:10:13:8:3. Clypeus convex; punctures on cylpeus coarser apically, otherwise equal to those on rest of face; apical impunctate band two thirds as wide medially as greatest width of scape. Ocelloccipital and ocellocular lines equal, postocellar shorter. First segment of flagellum one and three-fourths times longer than pedicel. Hypostomal carina moderately high, highest well behind angle, gradually reduced forward; hypostomal area in general convex, punctures very coarse. Tibial spines on fore and middle legs evenly produced. Longest hairs on fore basitarsus seven ninths as long as basitarsus. Strigilis with apex of velum oblique, apex of malus produced into a long, sharp, downward projecting spine, inner apical angle weakly convex. Hind tibial spurs long, slender, gently curving from bases to apices. Papillae on apex of fore wing fine, dense; hair in cells short, dense. Mesoscutum shining, punctures confluent, coarser and much deeper than shallow punctures on metasomal terga. Propodeal triangle entirely dull and reticulate. Apical impunctate bands of metasomal terga one to five not more than one seventh as wide as punctate portions; bands one and two polished, three finely lined and shining, four and five checkered and dull.

Distribution: Apparently along the Pacific Coast States although specimens are on hand from only California and British Columbia. Holotype and fifteen paratypes, Black's Mountain, Lassen County, California, on *Allium*, June 13, 1941 (C. D. Michener); eighteen paratypes, Black's Mountain, Lassen County, California, June 13, 1941 (P. D. Hurd); one paratype, Manzanita Lake, Lassen National Park, California, June 13, 1941; one paratype, West Walker River,

Mono County, California, June 25, 1937 (C. D. Michener); two paratypes, Big Spring, Shasta County, California, May 23, and June 10, 1941 (C. D. Michener); one paratype, Walker, Siskiyou County, California, June 2, 1920 (C. L. Fox); one paratype, Keremeos, British Columbia, August 8, 1923 (P. N. Vroom).

The holotype and fourteen paratypes are in the Snow Entomological Collection at the University of Kansas; fifteen paratypes will be returned to the University of California at Berkeley; three paratypes will be returned to the California Academy of Sciences; three paratypes will be sent to the United States National Museum; two paratypes will be sent to the American Museum of Natural History; and two paratypes will be sent to the Canadian National Collection.

Osmia dakotensis Michener

(Plate XXXIX, fig. 3)

Osmia dakotensis Michener, 1936, Ann. Mag. Nat. Hist., ser. 10, vol. 19, p. 407 (female); Peck and Bolton, 1946, Sci. Agr., vol. 26, p. 389 (record); Stevens, 1949, Bimonthly Bull. North Dakota Agr. Expt. Sta., vol. 11, p. 211.
Osmia dacotensis Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 62 (female).

This species is very close to *O. giliarum* Cockerell, and may prove, after more material can be studied, to be a color form of that species. These two species are taken at the same localities but because of the more sharply curved hind tibial spurs and the white hairs on the sides of the thorax of *dakotensis,* it is retained as a valid species. It can be separated from *O. nifoata* Cockerell and *O. physariae* Cockerell by the hind tibial spurs, and by the entirely white hair on the dorsum of the thorax.

Female: Length of body, 8 to 8½ mm.; fore wing, 6½ mm.

Paraocular areas, genae, sides of thorax and abdomen, propodeal triangle, blue; abdomen bluish green; elsewhere from dark to light olive green; ventral body surfaces, except mesepisternum and metasomal sterna, brown, legs black to brown. Hair: On thorax, propodeum, metasomal terga one and two, recumbent hair on tergum six, white; on clypeus, hypostomal areas, scopa, black; on upper surface of fore tarsus golden; on lower surfaces of all tarsal segments reddish brown; apices of femora fringed with short white hairs; elsewhere black and white mixed, with black predominate on legs, white predominate on metasomal terga.

Mandible with superior apical angle acute; no lower truncation on triangular upper tooth, which is equal in length to triangular middle tooth, the two being separated by a moderately wide, deep, V-shaped notch, the edges of which are concave; lower tooth longer

(one third longer than middle), slender, separated from middle by a wide arcuate notch; mandibular carinae parallel, upper carina about twice as high medially as lower, the two carinae being equal in width, space between them narrow; apex of mandible two times wider than constriction (Plate XXXIX, fig. 3). Trophi: Length of first segment of labial palpus is to second as 4:3; relative lengths of segments of maxillary palpus from base to apex, as 7:12:14:8:5. Clypeus rather strongly convex; punctures on clypeus apically finer than, basally subequal to those on rest of face; apical impunctate band one half as wide medially as greatest width of scape, band with transverse furrow absent. Postocellar and ocellocular lines equal, ocelloccipital subequal to others. First segment of flagellum one and one-half times longer than pedicel. Hypostomal carina low, highest well behind angle, gradually reduced forward; hypostomal area in general convex, punctures coarse. Tibial spines on fore and middle legs evenly produced. Longest hairs on fore basitarsus two thirds as long as basitarsus. Strigilis with apex obliquely acuminate, spine short, blunt, inner apical angle broadly rounded. Hind tibial spurs moderately long and wide, with apical fourth strongly curved. Papillae on apex of fore wing fine, dense; hair in cells short, sparse. Mesoscutum shining. Punctures on metasomal terga as in *giliarum*. Propodeal triangle dull and reticulate above, heavily lined, but shining below. Apical impunctate band on metasomal tergum one practically absent, band on tergum two is one seventh as wide as punctate portion, on terga three to five one fourth as wide as punctate portions; bands two and three finely lined, shining, on four and five, checkered and shining.

Distribution: From North Dakota southward through Montana and Wyoming to Colorado. The following list of localities include those of all the twenty-four specimens studied: *North Dakota:* Mott (C. N. Ainslie); Bowman, on *Astragalus*, June 23, 1918 (O. A. Stevens, paratype); *Montana:* Bozeman, June 30, 1916; Helena, July 11, 1907; *Wyoming:* Medicine Bow, June 23, 1920; Pine Bluffs, June 9, 1920; *Colorado:* Manitou, June 9, 1926 (E. C. Van Dyke); Pueblo, May 21, 1918 (A. Wetmore).

The type specimen is in the collection of O. A. Stevens, presumably now at the American Museum of Natural History, and a paratype is in the United States National Museum.

Osmia giliarum Cockerell

(Plate XXXIX, fig. 1)

Osmia giliarum Cockerell, 1906, Bull. American Mus. Nat. Hist., vol. 22, p. 451 (female); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 123 (key); Beck, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 304 (record); Cockerell, 1935, American Mus. Novitates, no. 766, p. 2 (female); Michener, 1936, American Mus. Novitates, no. 875, p. 22; Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 62 (female).

This is a Rocky Mountain species and although it has been recorded from Oregon, the specimens available from that State have been incorrectly identified. It is so close to *O. dakotensis* Michener that I believe when more material can be studied *dakotensis* may prove to be a color form of *giliarum* (they are taken together). These two species can be separated by the dusky to black hairs on genae and sides of thorax, the straighter hind tibial spurs, and the predominate black hair on the metasomal terga two to six, in *giliarum*. It is separated from *O. nifoata* Cockerell and *O. physariae* Cockerell, by the entirely white hair on the dorsum of the thorax.

Female: Length of body, 8 to 9 mm.; fore wing, 6 mm.

Vertex of head, dorsum of thorax, light olive green; metasomal terga dark olive green; elsewhere dark blue; ventral body surfaces, except mesepisternum, nonmetallic, brown. Legs dark brown or black. Hair: On vertex of head, dorsum of thorax, propodeum except on sides, metasomal tergum one except thin lateral patches, white; on face except clypeus, metasomal terga two to six, mixed (white hairs progressively fewer in number from two to six, with black hair predominate on all); on upper surface of fore tarsus golden; on lower surfaces of all tarsal segments and hind tibiae reddish brown; elsewhere dusky to black (hair on clypeus black, on genae dusky).

Mandible with superior apical angle acute; no lower truncation on triangular upper tooth, which is equal in length to triangular middle tooth, the two being separated by a moderately wide, deep V-shaped notch, only the lower edge of which is concave; lower tooth longer (three-fourths longer than middle tooth), wider, separated from middle by a shallow, narrow V-shaped notch; mandibular carinae parallel, the carinae equal in width, and equally raised, space between them narrow; apex of mandible one and three-fourths times wider than constriction (Plate XXXIX, fig. 1). Trophi: Length of first segment of labial palpus is to second as 6:7; relative lengths of segments of maxillary palpus from base to apex, as 10:10:15:7:4. Clypeus convex; punctures apically same

as between antennal bases, basally equal to those on rest of face; apical impunctate band one half as wide medially as greatest width of scape, band has transverse furrow. Postocellar, ocellocular, ocelloccipital lines subequal. First segment of flagellum subequal in length to pedicel. Hypostomal carina very low, highest at angle; hypostomal area in general convex, punctures moderately fine. Tibial spine on foreleg slightly longer than that on middle leg. Longest hairs on fore basitarsus three fourths as long as basitarsus. Strigilis with apex obliquely acute, spine short, sharp, inner apical angle broadly rounded. Hind tibial spurs long, slender, rather sharply curved at tips. Papillae on apex of forewing fine, dense; hair in cells short, moderately dense. Mesoscutum shining, punctures rather far apart medially to contiguous laterally, coarser, much deeper than very fine, shallow punctures on metasomal terga. Propodeal triangle dull and reticulate above, polished or finely lined and shining below. Apical impunctate bands of metasomal tergum one practically absent, bands on two to five at least one fourth as wide as punctate portions; bands two and three lined, shining; four and five checkered, shining.

Distribution: From Idaho southeastward through the Rocky Mountains to Colorado. The following are the localities of the eleven specimens studied: *Idaho:* Giveout, July 7, 1920; *Montana:* Bozeman, June 17, 1914; *Wyoming:* Laramie, June 14, 1920; Pine Bluff, June 9, 1920; *Colorado:* Elbert, on *Gilia,* June 3 (Figgins); Parker, on *Pentstemon,* May 11 (Figgins); Durango, June 4, 1936 (Rotger); Fort Garland, July 18 (L. Bruner); Gardner, June 1, 1942 (Rotger).

The type specimen is in the United States National Museum.

Osmia prunorum Cockerell

(Plate XL, fig. 3)

Osmia prunorum Cockerell, 1897, Canadian Ent., vol. 29, p. 65 (female only); Cockerell, 1897, New Mexico Coll. Agri. and Mechanic Arts, Agric. Expt. Station, Bull. 24, p. 28 (record); Cockerell, 1898, Bull. Univ. New Mexico, Bull. 1, p. 63 (key); Cockerell, 1898, Bull. Denison Univ., vol. 11, p. 63 (key); Cockerell, 1906, Trans. American Ent. Soc., vol. 32, p. 306 (record); Friese, 1911, Das Tierreich, Lief. 28, p. 156 (female); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 118 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 59 (female).

This species resembles *O. titusi* Cockerell most closely, but is distinguished by the darker scopal hairs and tegulae. In *titusi* the scopal hairs are entirely white, whereas, in *prunorum* they are fuscous toward the apices. Also, in *titusi* the hind tibial spurs are testaceous and the lower mandibular tooth is subequal in length to

the middle tooth (lower is one-half longer in *prunorum*). It may also be confused with *O. lupinicola* Cockerell and *O. liogastra* Cockerell; separated from *lupinicola* by the lower truncation on upper mandibular tooth and from *liogastra* by the entirely dark scopal hairs in that species.

Female: Length of body, 8 to 9 mm.; fore wing, 5½ to 6 mm.

Head blue; thorax blue to bluish green; abdomen darker blue than face; ventral body surfaces dark blue. Legs brown. Hair: On lower surfaces of all tarsal segments light brown; apices of scopal hairs fuscous; elsewhere white.

Mandible with superior apical angle produced above lower oblique to transversely truncate portion, forming an acute angle; upper tooth shorter than triangular middle tooth, the lower margin of which is convex and upper margin concave, the two being separated by a narrow, shallow, U-shaped notch lower tooth longer (five-eights longer than middle), rather wide, separated from middle by a narrow, deep, V-shaped notch; mandibular carinae slightly divergent toward apex of mandible, about equally raised, equal in width, space between them narrow; apex of mandible two times wider than constriction (Plate XL, fig. 3). Trophi: Length of first segment of labial palpus is to second as 4:5; relative lengths of segments of maxillary palpus from base to apex as 9:10:10:7:5. Clypeus weakly convex; punctures apically equal to those between antennal bases, otherwise equal to those on rest of face; apical impunctate band two thirds as wide medially as greatest width of scape, band has transverse furrow. Ocellocular, ocelloccipital, postocellar lines subequal. First segment of flagellum subequal in length to pedicel. Hypostomal carina rather high, almost evenly raised; hypostomal area in general convex, punctures coarse. Tibial spine on fore leg slightly longer than that on middle legs. Longest hairs on fore basitarsus three fourths as long as basitarsus. Strigilis with apex obliquely acuminate, spine rather long, sharp, inner apical angle more nearly an obtuse angle than rounded. Hind tibial spurs long, slender, straight. Papillae on apex of fore wing very fine, dense; hairs in cells short, sparse. Mesoscutum dull, punctures contiguous, coarser, deeper than fine punctures of metasomal terga. Propodeal triangle dull, reticulate. Apical impunctate bands of metasomal terga absent, punctures extending to apical margins of terga.

Distribution: The following is all the locality data available on the three specimens studied: *New Mexico:* Mesilla, April, 1909

(C. N. Ainslie); Ckll. 2678a, on *Sisymbrium*, co-type No. 3707 U.S.N.M.; Ckll. 2637, on plum.

The type specimen is in the United States National Museum.

Osmia titusi Cockerell

(Plate XXXIX, fig. 4)

Osmia titusi Cockerell, 1905, Canadian Ent., vol. 37, p. 370 (female); Cockerell, 1907, Ann. Mag. Nat. Hist., ser. 7, vol. 19, p. 369 (record); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 119 (key); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 112 (female).

This species resembles *O. primorum* Cockerell, but is distinguished by the testaceous tegulae and hind tibial spurs, the shorter, lower mandibular tooth, and the entirely white scopal hairs. Sandhouse (1939) placed this species in *Nothosmia* and associated it with a male. The species was originally described from a female which seems to belong in this subgenus because of the tridentate mandibles which are one and three-fourths times wider apically than at the constriction and because of the long hairs on the upper surfaces of the fore basitarsi. The male shows no characteristics of the subgenus and is therefore left as a supposedly unnamed male of *Nothosmia*. It is quite possible, however, that this is the true male of *titusi*. As pointed out in the introduction, there is a desert group, including *titusi*, whose females are rather arbitrarily included in *Acanthosmioides*. If the sexes of *titusi* were properly associated by Sandhouse, these bees should clearly be removed from *Acanthosmioides*.

The material studied showed no apparent variation. The writer is indebted to Mr. P. H. Timberlake for identifying the species and for the loan of additional specimens of *titusi*.

Female: Length of body, 7½ to 8½ mm.; fore wing, 5½ to 6 mm.

Metasomal terga light olive green, some with a golden tint; elsewhere light olive green, usually with a rose tint, some with a golden tint; ventral body surfaces metallic. Legs brown. Hair: entirely white, except light brown to reddish brown hair on lower surfaces of all tarsal segments.

Mandible with superior apical angle produced above lower, strongly oblique truncation to form an acute angle; upper tooth shorter than nearly triangular middle tooth, whose lower margin is convex, separated from same by a wide, shallow, V-shaped notch (arms of V uneven); middle tooth separated from longer lower tooth (one-fourth longer than middle) by a deep, wide, V-shaped notch; mandibular carinae parallel, the lower carina slightly wider than upper, the two being equally raised, space between them

narrow; apex of mandible one and three-fourths times wider than constriction (Plate XXXIX, fig. 4). Trophi: Length of first segment of labial palpus is to second as 5:7; relative lengths of segments of maxillary palpus from base to apex, as 10:11:13:9:5. Clypeus rather strongly convex; punctures on clypeus apically finer than, otherwise equal to, those on rest of face; apical impunctate band subequal in width medially to greatest width of scape, band has a transverse furrow. Postocellar and ocelloccipital lines equal, ocellocular one-fifth shorter. First segment of flagellum about one and one-fourth times longer than pedicel. Hypostomal carina low, highest well behind angle, very gradually reduced forward; hypostomal area in general convex, punctures coarse. Tibial spines on fore and middle legs equally produced. Longest hairs on fore basitarsus three fifths as long as basitarsus. Strigilis with apex obliquely acuminate, spine rather long, sharp, inner apical angle broadly rounded. Hind tibial spurs long, slender, gently curving for apical third (testaceous). Papillae on apex of fore wing fine, dense; hair in cells short, thick (wings entirely hairy). Mesoscutum shining, punctures contiguous, coarser, much deeper than very fine, shallow punctures of metasomal terga. Propodeal triangle polished below, reticulate and dull above. Punctures on metasomal terga extending to apices of terga.

Distribution: The deserts of Southern California. The following represent all of the localities of the four specimens studied: *California:* Kramer Junction, San Bernardino County, April 25, 1949 (R. F. Smith); Kramer Hills, May 3, 1939 (P. H. Timberlake); Adelanto, on *Astragalus,* April 25, 1937 (Timberlake); Borego Valley, San Diego County, on *Lupinus,* March 26, 1933 (Timberlake). The holotype is labeled "Los Angeles" but presumably came from the desert.

The type specimen is in the United States National Museum.

Osmia lupinicola Cockerell

(Plate I, figs. 10, 11)

Osmia lupinicola Cockerell, 1937, American Mus. Novitates, no. 948, p. 12 (female).

This is a rather small bee, and like other desert forms the pubescence is almost entirely white. Unlike *O. prunorum* Cockerell, *O. titusi* Cockerell, *O. liogastra* Cockerell, and others, it has the apical impunctate bands on the metasomal terga present. It is closest to *prunorum* and *titusi,* but easily distinguished by the tergal bands, and by the fact that there is no truncation on the upper mandibular

tooth. (The lower surface of this tooth is concave in some specimens and might lead to confusion, therefore it appears under both alternatives in the key.) In many ways it is similar to *O. sedula* Sandhouse, but can be separated from both *sedula* and *liogastra* by the lighter colored scopal hairs (the scopal hairs in some specimens are darker than in others but always are testaceous).

Female: Length of body, 7½ to 8 mm.; fore wing, 5½ to 6 mm.

Supra-antennal areas, genae, propodeum, metasomal terga, light olive green; dorsum of thorax greenish blue; elsewhere blue (some specimens are olive green on sides of thorax instead of blue); ventral body surfaces metallic. Legs dark brown, except metallic portions on fore and hind femora. Hair: On dorsum of thorax white with a few scattered dusky hairs (very few individuals entirely white); on lower surfaces of tarsi reddish brown; scopa dusky toward apices of hairs (a few individuals have entirely rufous to testaceous scopal hairs); elsewhere white.

Mandible with superior apical angle acute; no lower truncation on upper tooth, but lower edge convex; triangular middle tooth subequal in length to upper, separated by a deep, wide V-shaped notch; lower tooth only slightly longer than middle (one-sixth longer than middle), separated by a deep, wide V-shaped notch; mandibular carinae parallel, equal in width and equally raised, space between them narrow; apex of mandible one and three-fourths times wider than constriction (Plate XXXIX, figs. 10, 11). Trophi: Length of first segment of labial palpus is to second as 1.5:1.0; relative lengths of segments of maxillary palpus from base to apex as 10:10:13:7:3. Clypeus rather strongly convex; punctures much coarser than those on rest of face; apical impunctate band one half as wide medially as greatest width of scape, band has a transverse furrow. Postocellar and ocellocular lines subequal, ocelloccipital one-fourth longer. First segment of flagellum equal in length to pedicel. Hypostomal carina moderately high posteriorly, highest medially, rapidly reduced forward; hypostomal area in general convex, punctures coarse. Tibial spine on fore leg one-third shorter than that on middle leg. Longest hairs on fore basitarsus two thirds as long as basitarsus. Strigilis with apex obliquely acute, spine short, sharp, inner apical angle only slightly rounded (more nearly an obtuse angle). Hind tibial spurs long, slender, straight, except for slightly curved tips. Papillae on apex of fore wing fine, dense; hairs in cells short, dense. Mesoscutum shining, punctures confluent, coarser than fine, close punctures on metasomal terga. Propodeal triangle reticulate but shining. Apical impunctate bands of metaso-

mal terga four and five about one third as wide as punctate portions, two and three about one seventh as wide as punctate portions, absent on first; bands checkered and dull.

Distribution: Known only from the arid portions of the Southern California mountains. The following is a list of the specimens studied: Piñon Flat, San Jacinto Mountains, on *Nolina,* May 18, 1939 (E. S. Ross); Piñon Flat, San Jacinto Mountains, May 15, 1941 (E. C. Van Dyke); Santa Rosa Mountain, San Jacinto Mountains, on *Lotus davidsonii,* May 31, 1940 (C. D. Michener); Morongo, San Bernardino County, April 20, on *Lupinus* (W. P. Cockerell, this specimen is the holotype).

The type specimen is in the Amerian Museum of Natural History.

Osmia liogastra Cockerell

(Plate XXXIX, fig. 2)

Osmia liogastra Cockerell, 1933, Pan-Pacific Ent., vol. 9, p. 26 (female); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 138 (female).

This species runs to the region of *O. dakotensis* Michener in the key but is actually more easily confused with *O. sedula* Sandhouse. It is distinguished from *dakotensis* by the sharply curved hind tibial spurs in that species, and by the absence of the apical impunctate bands on the metasomal terga in *liogastra;* from *sedula* by the absence of a lower truncation on the apex of the upper mandidular tooth. A combination of the following characters usually distinguish this species from others in the subgenus: upper mandidular tooth triangular, apical impunctate bands of metasomal terga absent, scopal hairs fuscous to black (never light). Sandhouse (1939) left this species unassigned but mentioned that it might belong to *Acanthosmioides.*

Female: Length of body, 7 to 8 mm.; fore wing, 4½ to 5 mm.

Metasomal terga, propodeal triangle, genae, greenish-blue; sides of thorax dark blue; elsewhere olive green; ventral body surfaces metallic, but darker than above. Legs dark brown. Hair: On scopa black; on face, dorsum of thorax, black and white mixed; on lower surfaces of all tarsal segments light brown to reddish brown; elsewhere white.

Mandible with superior apical angle acute; no lower truncation on triangular upper tooth, which is equal in length to triangular middle tooth, the two being separated by a wide, rather shallow, U-shaped emargination; lower tooth longer (one-half longer than middle), separated from middle by a wide, shallow V-shaped notch; mandibular carinae divergent toward base of mandible,

lower carina slightly wider than upper, equally raised, space between them narrow; apex of mandible one and three-fourths times wider than constriction (Plate XXXIX, fig. 2). Trophi: Length of first segment of labial palpus is to second as 4:5; relative lengths of segments of maxillary palpus from base to apex, as 7:8:10:6:4. Clypeus strongly convex; punctures apically subequal to those on rest of face, coarser basally; apical impunctate band one half as wide medially as greatest width of scape, band has transverse furrow. Postocellar and ocellocular lines subequal, ocelloccipital one-fourth longer. First segment of flagellum hardly longer than pedicel. Hypostomal carina low, almost evenly raised; hypostomal area in general convex, punctures moderately fine, equal to punctures on genae. Tibial spine on middle legs longer than on fore leg. Longest hairs on fore basitarsus six sevenths as long as basitarsus. Strigilis with apex obliquely acute, spine short, sharp, inner apical angle broadly rounded. Hind tibial spurs long, straight, slender. Papillae on apex of fore wing fine, dense; hairs in cells short, moderately dense. Mesoscutum shining, punctures contiguous, coarser, slightly deeper than those on metasomal terga. Propodeal triangle polished below, reticulate and dull above. Apical impunctate bands of metasomal terga very narrow, punctures extending almost to apices of terga.

Distribution: Known only from the deserts of southern and central California. The following are the two localities in which the three specimens studied were taken: Borego Valley, San Diego County, on *Lupinus,* March 26, 1933 (Timberlake); Lone Pine, Inyo County, May 19, 1937 (C. D. Michener).

The type specimen is located in the Timberlake Collection at the Citrus Experiment Station, Riverside, California.

Osmia morongana Cockerell

(Plate I, fig. 8)

Osmia morongana Cockerell, 1937, American Mus. Novitates, no. 948, p. 12 (female).

This species runs to the region of *O. physariae* Cockerell in the key but is easily distinguished from that species by the narrow, apical, impunctate bands which are much duller than in *physariae.* This species occurs in the desert regions of California, but differs from other desert species included in this paper by the predominance of black hair.

Female: Length of body, 7 to 8 mm.; fore wing, 5½ mm.

Clypeus dark brown, nonmetallic; sides of thorax, sides of meta-

somal terga, paraocular regions, blue; elsewhere dark greenish blue; ventral body surfaces nonmetallic, dark brown. Legs brown. Hair: On clypeus, metasomal sterna (scopa), black; on genae, mesepisternum, dusky to black; on upper surfaces of all tibiae and all tarsal segments, tawny; on lower surfaces of all tarsal segments reddish brown; elsewhere black and white mixed.

Mandible with superior apical angle acute; no lower truncation on triangular upper tooth, which is subequal in length to triangular middle tooth, the two being separated by a moderately wide, V-shaped notch, upper margin of which is rather strongly convex; lower tooth very little longer (one sixth longer than middle tooth), wider, separated from middle by a deep, narrow V-shaped notch; mandibular carinae parallel, equal in width, equally raised, space between them rather wide; apex of mandible one and three fourths times wider than constriction (Plate XXXIX, fig. 8). Trophi: Length of first segment of labial palpus is to second as 5.0:6.5; relative lengths of segments of maxillary palpus from base to apex, as 5:11:10:8:4. Clypeus convex; punctures coarser than those on face; apical impunctate band three fourths as wide medially as greatest width of scape, transverse furrow absent. Postocellar and ocelloccipital lines subequal, ocellocular shorter. First segment of flagellum subequal in length to pedicel. Hypostomal carina moderately high, highest well behind angle, gradually reduced both anteriorly and posteriorly; hypostomal area in general convex, punctures coarse. Tibial spine on foreleg longer than that on middle leg. Longest hairs on fore basitarsus subequal in length to basitarsus. Strigilis with apex obliquely acute, spine long, sharp, inner apical angle not rounded, nearly a right angle. Hind tibial spurs moderately long, slender, straight. Papillae on apex of fore wing fine, dense; hair in cells short, moderately thick. Mesoscutum dull, punctures confluent, much deeper than fine, shallow punctures on metasomal terga. Propodeal triangle dull and reticuulate above, polished or finely lined and shining below. Apical impunctate band on metasomal tergum one absent, band on two very narrow, about one twelfth as wide as punctate portion, bands on three, four, and five one sixth as wide as punctate portion; all bands checkered, dull.

Distribution: Known only from the desert regions around Morongo, California. The following is the locality of the type, which was the only specimen studied: Morongo, San Bernardino County, on *Lupinus*, April 20 (Cockerell).

The type specimen is in the American Museum of Natural History.

Osmia longula Cresson

(Plate XXXIX, fig. 14; Plate XL, fig. 12; Plate XLI, fig. 11; Plate XLII, fig. 12; Plate XLIII, fig. 12; Plate XLIV, fig. 3)

Osmia longula Cresson, 1864, Proc. Ent. Soc. Philadelphia, vol. 3, p. 19 (female); Cockerell, 1910, Univ. Colorado Studies, vol. 7, p. 90 (record); Friese, 1911, Das Tierreich, Lief. 28, p. 154 (female); Cresson, 1916, Mem. American Ent. Soc., no. 1, p. 22 (record); Cockerell, 1919, Ent. News, vol. 30, p. 294 (record); Sandhouse, 1925, Canadian Ent., vol. 57, pp. 40, 60 (key, record); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 122 (key); Beck, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 304 (record); Michener, 1936, American Mus. Novitates, no. 875, p. 25 (record); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 45 (male, female).

Osmia abnormis Cresson, 1878, Trans. American Ent. Soc., vol. 7, p. 105 (male); Friese, 1911, Das Tierreich, Lief. 28, p. 147 (male); Cockerell, 1915, Ann. Mag. Nat. Hist., ser. 8, vol. 16, p. 484; Cresson, 1916, Mem. American Ent. Soc., vol. 1, p. 110 (record); Kenoyer, 1916, Proc. Iowa Acad. Sci., vol. 23, p. 484 (plant record); Clements and Long, 1923, Expt. Pollination, Carnegie Inst. Washington Publ., no. 336, p. 253 (record); Cockerell, 1928, Univ. Colorado Studies, vol. 16, pp. 116-121 (key); Beck, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 303; Sandhouse, 1929, Canadian Ent., vol. 57, pp. 10, 35 (key, record); Rodeck, 1934, Ent. News, 45: 66.

Osmia grandior Cockerell, 1897, Proc. Acad. Nat. Sci. Philadelphia, vol. 49, p. 343 female); Friese, 1911, Das Tierreich, Lief. 28, p. 152 (female).

Melanosmia grandior Titus, 1906, Proc. Ent. Soc. Washington, vol. 7, p. 156 (female).

Osmia permorata Cockerell, 1910, Canadian Ent., vol. 42, p. 310 (female); Cockerell, 1914, Ann. Mag. Nat. Hist., ser. 8, vol. 14, p. 363 (record); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 121 (key); Beck, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 305 (record); Rodeck, 1934, Ent. News, vol. 45, p. 66.

The males of this species are easily distinguished by the presence of a mid-apical projection on both the first and second metasomal sterna, also by the widened terminal segment of the flagellum. In size this species is closest to *O. integra,* but that species lacks sternal processes altogether. The females resemble very closely those of *integra,* because of their size and the red thoracic hair of many individuals; they are distinguished by the absence of a truncation on the upper mandibular tooth and by the elongate first flagellar segment. There is considerable variation in hair color on the vertex and the dorsum of the thorax in both sexes, and the amount of white hair on the genae and supra-antennal areas of the males. Generally more of the Californian specimens have red hair than white and the Oregon specimens more white hair, but both red and white forms are found throughout the range of the species.

Male: Length of body, 11 to 14 mm.; fore wing, 8 to 10 mm.

Mandible black, dark red on teeth; flagellum black above, dark brown below; legs black. Paraocular regions and sides of clypeus blue; genae, sides of thorax, propodeum, metasomal terga, dark blue to dark greenish blue; vertex of head, dorsum of thorax, dark greenish blue to olive green. Hair: Long, that on face, vertex of

head, ventral surface of head, mesepisternum, fringe on posterior surface of foreleg from coxa to femora, dorsum of thorax, and first metasomal tergum, tawny to white (varying to fulvous on dorsum of thorax); on second metasomal tergum, except thick lateral patches, white; on genae, posterior surface of fore tibia, propodeum, third metasomal tergum, black and white mixed; on upper surface of fore tarsus tawny; on lower surfaces of all tarsal segments reddish brown; elsewhere black.

Mandible with a very narrow, shallow, V-shaped notch separating upper tooth from long, slender, lower tooth; apical edge above notch strongly oblique, unmodified, superior apical angle obtuse to almost a right angle, mandibular carinae parallel, lower one wider than upper, which is about one-half higher medially, space between them narrow (Plate II, fig. 12). Trophi: Length of first segment of labial palpus is to second as 6.0:6.1; relative lengths of segments of maxillary palpus from base to apex as 10:16:20:8:7. Clypeus convex, margin toothed; punctures same as those of surrounding areas and area between antennal bases, finer than those on rest of face; apical impunctate band about one half as wide medially as greatest width of scape. Postocellar and ocellocular lines equal, ocelloccipital longer. Hypostomal carina low, highest well back of angle, gradually reduced anteriorly. Flagellum weakly crenulate, last segment with inner edge produced, being one third wider at its greatest width than preceding segments. Tibial spine on middle leg longer and wider than that on fore leg. Strigilis with apex of velum strongly oblique, lower apical angle truncate, apex of malus truncate, extending but little beyond velum, curving downward. Segments of fore tarsus greatly enlarged, progressively smaller through mediotarsus; basitarsus with anterior margin greatly enlarged, arising abruptly from near base of segment, increasing gradually to greatest width just before apex, its upper surface broadly concave longitudinally; second and third tarsal segments with anterior margins lobate. Posteroventral surface of middle coxa produced; middle basitarsus twice as long as wide, anterior margin produced at apex. Hind basitarsus twice as long as wide, widest in middle, its upper surface longitudinally concave; hind tibial spurs long, slender, straight. Papillae on apex of forewing coarse, dense; hairs in cells long, moderately dense. Propodeal triangle dull, reticulate. Metasomal terga: Apical impunctate bands of terga two to five, one fourth as wide as punctate portions, polished on second, finely lined, shining on three to five; sixth with apical third slightly turned up, surface smooth, mid-

apex with a small V-shaped notch; seventh with mid-apical emargination of produced portion deep, U-shaped, on each side the tooth is short, blunt, as wide as emargination. Metasomal sterna: First with ventral surface flat, median impunctate stripe, slender, spinelike mid-apical projection; second with process arising on midline of ventral surface before apex, hardly extending beyond apical margin of sternum, thin, keellike in ventral view, lower margin increasing gradually to wide, truncate apex, as viewed laterally (sternum fringed laterally with very long black hair); third with mid-apical concavity deep, rather wide, fringed with long golden hairs, lateral patches thick, long, black; fourth with median third produced apically, its apex shallowly concave, median apical patch of bristlelike hairs bent mesad at tips, surrounding a rectangular impunctate portion which extends to apex, lateral patches thin, long, black (Plate XLI, fig. 11); fifth with apex broadly, shallowly concave, very sparse, bristlelike hairs present mid-apically; sixth with a mid-apical produced portion, its apex with a broad V-shaped notch, lateral teeth and V-shaped carina absent (Plate XLII, fig. 12). Eighth sternum and gonocoxite as shown in Plate XLIII, fig. 12, and Plate XLIV, fig. 3.

Female: Length of body, 11 to 14 mm.; fore wing, 10 to 11 mm.

Vertex of head and dorsum of thorax greenish blue; elsewhere dark blue; ventral body surfaces nonmetallic, black. Legs dark brown to black. Hair: On vertex of head, dorsum of thorax, first metasomal tergum, median basal portion of second tergum, cream to tawny (varying to red on vertex and thoracic dorsum of some specimens); on fore and middle tarsi light brown to reddish brown; on lower surface of hind tarsus reddish brown; some specimens with a patch of black and white hairs on supra-antennal area; elsewhere black including fringes on apices of femora.

Mandible with superior apical angle acute, almost a right angle; no lower truncation on upper tooth which is shorter than nearly triangular middle tooth, lower margin of which is rather strongly convex, the two being separated by a wide, shallow, arcuate notch; lower tooth very long, slender (three times longer than middle), separated from middle by a deeper, wide V-shaped notch; mandibular carinae parallel, lower slightly wider than upper, about two thirds as high medially as upper, space between them narrow; apex of mandible almost two and one half times wider than constriction (Plate I, fig. 14). Trophi: Length of first segment of labial palpus is to second as 5:5; relative lengths of segments of maxillary palpus from base to apex as 11:15:14:10:6. Clypeus convex; punctures

equal to those on rest of face; apical impunctate band two thirds as wide medially as greatest width of scape, band has transverse furrow absent. Ocellocular and ocelloccipital lines subequal, postocellar one fourth shorter. First segment of flagellum two and one-fourth times longer than pedicel. Hypostomal carina low, highest well behind angle, rather rapidly reduced forward. Tibial spines evenly produced on fore and middle legs. Longest hairs on fore basitarsus five eighths as long as basitarsus. Strigilis with apex obliquely acute, spine short, blunt, inner apical angle broadly rounded. Hind tibial spurs long, slender, slightly curved at tips. Papillae on apex of fore wing coarse, dense; hair in cells short, moderately thick. Mesoscutum dull, punctures contiguous madially, confluent laterally, much deeper than shallow, widely-spaced punctures of metasomal terga. Propodeal triangle minutely checkered, dull. Apical impunctate bands of metasomal terga about one fourth as wide as punctate portions; bands on one to three polished, four and five finely lined, shining.

Distribution: From central California to British Columbia, southeastward through Montana and Wyoming to Colorado and Utah. From fifty-one specimens studied the following localities are selected to show the distribution: *California:* Summit of Sonora Pass, June 27, 1937 (C. D. Michener), June 26, 1937 (E. C. Van Dyke); Mono Lake, June 16, 1917 (C. L. Fox); Yosemite, July 15, 1934 (J. E. Mabry); Hope Valley, Alpine County, July 9, 1948 (P. D. Hurd); Eldorado Springs, May 22, 1921 (L. O. Jackson); Sylvan Pass, June 18, 1930 (E. C. Van Dyke); *Oregon:* Bone Springs, Blue Mountains, June 7, 1938 (E. C. Van Dyke); La Grande, May 12, 1930 (H. A. Scullen); *British Columbia:* Victoria, May 20, 1917 (A. E. Cameron), May 5, 1919 (W. Downes); Vancouver Island (G. W. Taylor); Departure Bay, May 1, 1919; Saanich, May 20, 1929 (W. H. Preece); Chilcotin, June 9, 1920 (E. R. Bucknell); Royal Oak, May 31, 1917 (R. C. Treherne); Fitzgerald, June 3, 1921 (W. R. Carter); Vernon, February 24, 1946, removed from pupal cell (H. B. Leech); *Montana:* Missoula, May 19, 1904; *Wyoming:* Yellowstone National Park, June 26, 1930 (E. C. Van Dyke); Jenny Lake, Grand Tetons, June, 1941 (G. E. Bohart); Foxpark, June 15, 1920; *Colorado:* Pingree Park, August 19, 1935 (M. and H. James); Ward, June 29, 1922 (T. D. A. Cockerell); Science Lodge, Boulder County, June 22, 1939 (U. N. Lanham); Poudre River, June, 1888 (T. Pergande); Fort Collins, June 12, 1900; Los Pinos, May 22, 1899 (C. F. Baker); Elbert (Cockerell); Red Cliff (Wickham); Paonia, Delta County, June 15, 1926 (E. C.

Van Dyke); *Utah:* Uinta, June 21, 1949 (J. K. Haws); Uinta National Forest, June 28, 1917 (R. A. Silver); Rock Cañon.

The type specimens of *longula* and *abnormis* are located in the Academy of Natural Sciences of Philadelphia; of *grandior* and *permorata* in the United States National Museum.

Osmia integra Cresson

(Plate I, fig. 13; Plate II, fig. 14; Plate III, fig. 12; Plate IV, fig. 11; Plate V, fig. 8; Plate VI, fig. 9)

Osmia integra Cresson, 1897, Trans. American Ent. Soc., vol. 7, p. 106 (male); Cockerell, 1893, Trans. American Ent. Soc., vol. 20, p. 338 (list); Cockerell, 1910, Ent. News, vol. 21, pp. 171, 271 (record, key); Friese, 1911, Das Tierreich, Lief. 28, p. 153 (male); Cockerell, 1911, Trans. American Ent. Soc., vol. 37, p. 235 (record); Cresson, 1916, Mem. American Ent. Soc., no. 1: 120 (record); Bray, 1917, Pomona Jour. Ent. Zoo., vol. 9, p. 96 (record); Sandhouse, 1924, Proc. California Acad. Sci., ser. 4, vol. 13, pp. 359, 369 (key, record); Sandhouse, 1925, Canadian Ent., vol. 57, pp. 37, 66 (key, record); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 116 (key); Beck, 1929, Bull. Brooklyn Ent. Soc., vol. 24, p. 304 (record); Sandhouse, 1939, Mem. Ent. Soc. Washington, no. 1, p. 56 (male, female).

Osmia integra nigrigena Michener, 1936, Bull. So. California Acad. Sci., vol. 35, p. 90 (male, female).

Osmia novomexicana Cockerell, 1903, Ent. News, vol. 14, p. 339 (female); Cockerell, 1906, Canadian Ent., vol. 38, p. 161 (record); Cockerell, 1906, Trans. American Ent. Soc., vol. 32, p. 306 (record); Cockerell, 1907, Univ. Colorado Studies, vol. 4, p. 251 (key); Gibson, 1910, Rept. Ent. Soc. Ontario, 1910, p. 18 (record); Cockerell, 1911, Canadian Ent., vol. 43, p. 33 (record); Cockerell, 1916, Pomona Jour. Ent. Zoo., vol. 8, p. 3 (record); Hicks, 1926, Univ. Colorado Studies, vol. 15, p. 26 (biology); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 121 (key).

Osmia florissanticola Cockerell, 1906, Bull. American Mus. Nat. Hist., vol. 22, p. 450 (female); Cockerell, 1907, Ann. Mag. Nat. Hist., ser. 7, vol. 20, p. 449 (record); Cockerell, 1928, Univ. Colorado Studies, vol. 16, p. 121 (key).

This species and *O. longula* Cresson are the largest species in the subgenus. They agree also in often having red hair on the dorsum of the thorax. The male differs from other species by the absence of a process on the second metasomal sternum and in the presence of a distinctive median-ventral band of long black hairs. The females are distinguished from those of *longula* by the concave truncation on the upper mandibular tooth and by the shorter first flagellar segment. Smaller specimens of *integra* somewhat resemble *O. nigrifrons* Cresson but again the truncation on the upper mandibular tooth will separate them. The amount of white or red hair varies greatly and apparently has no subspecific significance since extremes of the variation occur in the same locality.

Phylogenetic studies may show this species to belong to another subgenus (possibly *Melanosmia*).

Male: Length of body, 11 to 14 mm.; fore wing, 8 to 9¼ mm.

Mandible black, base nonmetallic; flagellum light below, dark

above; legs dark brown, except metallic fore and hind femora in some specimens. Vertex of head, dorsum of thorax, olive green; rest of head, sides of thorax, propodeum, metasomal terga, blue. Hair: Long, on face, vertex of head, sides of thorax (except black patches on mesepisternum and sides of propodeum), propodeum, first and second metasomal terga, white; on dorsum of thorax white to red (never as dark red as in some females); mid-apical emargination of third metasomal sternum fringed with golden yellow hairs; posterior surface of femur of fore leg with black and white hair mixed; inner surfaces of all tarsal segments with tawny to reddish hair; elsewhere black.

Mandible with rather wide, deep, V-shaped notch separating upper tooth from long lower tooth; apical edge above notch nearly truncate, with superior apical angle slightly produced, forming an acute angle; mandibular carinae parallel, upper carina slightly higher than lower, space between them narrow (Plate XL, fig. 14). Trophi: Length of first segment of labial palpus is to second as 11.1:11.0; relative lengths of segments of maxillary palpus from base to apex as 14:18:22:10:7. Clypeus weakly convex, apex toothed; punctures same as areas immediately surrounding clypeus, gradually becoming larger to just above bases of antennae, where they are much larger; apical impunctate band two thirds as wide medially as greatest width of scape. Postocellar and ocellocular lines nearly equal, ocelloccipital three fourths longer. Hypostomal carina moderately raised, highest just before angle, gradually reduced forward. Flagellum very weakly crenulate, last segment no wider than preceding segments. Tibial spines on fore and middle legs equally produced. Strigilis with apex of velum truncate, apex of malus produced into a short, sharp spine, projecting slightly downward. Segments of mediotarsus of fore leg slightly swollen; second tarsal segment as wide as long, three and four progressively shorter, and narrower; basitarsus three and one-third times longer than wide. Middle leg with coxa unmodified; mediotarsal segments not swollen, longer than wide. Hind basitarsus almost uniformly widened, apex subtruncate; hind tibial spurs long, stout, slightly curved at apices. Papillae on apex of fore wing coarse, sparse; hair in cells short, sparse. Propodeal triangle dull and reticulate above, polished below (some specimens entirely dull). Metasomal terga: Apical impunctate bands of terga two to five one third as wide as punctate portion; bands on two and three checkered, dull; on four and five finely lined, shining; sixth tergum with very small apical fold, surface with two lateral dents,

one median dent, mid-apex not emarginate; seventh with mid-apical emargination of produced portion very shallow, on each side the tooth is short, blunt. Metasomal sterna: First with apex truncate; second with no process, but apex broadly triangular, mid-apex shallowly concave, ventral surface with long black hairs laterally, sub-apically, and medianly, median hairs forming a distinct longitudinal band; third with mid-apical concavity shallow, rather wide, fringed with fine golden hairs, margin of sternum to each side of concavity fringed with sub-apical black hairs, longest hairs being lateral; fourth with mid-apical tenth non-pubescent, immediately anterior to which is a wide patch of short, straight, bristlelike hairs with a median impunctate stripe, lateral patches longer, sub-apical patches sparse (Plate XLI, fig. 12); fifth with mid-apical, triangular patch of thin, sparse hair which has a median impunctate portion (fourth and fifth very similar in outline, apical margin nearly truncate); sixth with mid-apical produced portion, its apex with a broad, shallow, V-shaped emargination, forming to each side a short, straight, blunt tooth, V-shaped carina anterior to apex absent (Plate XLII, fig. 11). Eighth metasomal sternum and gonocoxite as shown in Plate XLIII, fig. 8, and Plate XLIV, fig. 9.

Female: Length of body, 10 to 14 mm.; fore wing, 7½ to 10 mm.

Vertex of head, dorsum of thorax, olive green; elsewhere dark blue; ventral body surfaces, except mesepisternum, nonmetallic, brown to black. Legs light brown or fulvous to black. Hair: On vertex of head, dorsum of thorax, white to red; on metasomal tergum one white, except for thin lateral black patches; on metasomal tergum two mixed; on metasomal tergum six with recumbent dusky hairs; lower surfaces of tarsi with golden brown hair; apices of femora with sparse fringes of white hairs; elsewhere black.

Mandible with superior apical angle acute, above a lower subtruncate portion, the outer surface of which is concave; upper tooth shorter than nearly triangular middle tooth, lower margin of which is convex, separated from same by a rather shallow V-shaped emargination; middle separated from long (one and one-half times longer than middle), wide, lower tooth by a deep, V-shaped notch; mandibular carinae parallel, lower carina twice as wide as upper, which is about one-third higher medially, space between them narrow; apex of mandible two and one-half times wider than constriction (Plate XXXIX, fig. 13). Trophi: Length of first segment of labial palpus is to second as 10.1:10.0; relative lengths of segments of maxillary palpus from base to apex as 10:17:20:10:7. Clypeus

weakly convex; punctures coarser than those between antennal bases, but subequal to those on rest of face; apical impunctate band one half as wide medially as greatest width of scape. Postocellar, ocellocular, ocelloccipital lines as 3:5:9. First segment of flagellum one-fourth longer than pedicel. Hypostomal carina high, highest just behind angle, rather rapidly reduced forward. Tibial spines about evenly produced on fore and middle legs (short for size of species). Longest hairs on fore basitarsus nearly equal in length to basitarsus. Strigilis with apex obliquely acute, spine short, blunt. Hind tibial spurs long, thick, apical third sharply curved. Papillae on apex of fore wing coarse, dense; hair in cells short, dense. Mesoscutum shining, punctures confluent, coarser, much deeper than very shallow punctures of metasomal terga. Propodeal triangle dull and reticulate above, polished below. Apical impunctate bands of metasomal terga one to five one fourth (some specimens one third) as wide as punctate portions, bands reticulate, dull to finely lined, shining.

Distribution: California to British Columbia, eastward to Manitoba, southward through the Rocky Mountains to New Mexico. In addition, a specimen from Arizona and one from Texas have been examined. The following are selected localities, from the seventy-four specimens studied, to show the distribution: *California:* Altadena, Los Angeles County, on *Lotus,* May 23, 1936 (C. D. Michener); San Francisco, May 1911; Mount Tamalpais, Marin County, May 13, 1911 (J. A. Kusche); Sand Dunes, San Francisco, March 13, 1911; Trinidad, Humboldt County, June 6, 1925 (J. O. Martin); Mono County near Whitmore Hotsprings, June 24, 1937 (E. C. Van Dyke); Truckee, June 27, 1927 (E. P. Van Duzee); Plumas County, June 25, 1949 (P. D. Hurd); *Oregon:* Hermiston, May 4, 1927 (H. A. Scullen); *Washington:* Walla Walla, May 28, 1938 (G. E. Bohart); Touchet, April 22, 1933 (M. C. Lane); *British Columbia:* Chilcotin, May 14, 1920 (E. R. Bucknell); Invermere, June 30, 1914; Nicola, May 29, 1922 (P. N. Vroom); *Alberta:* Medicine Hat, June 12, 1923 (F. S. Carr); Banff, June 23, 1915 (Sanaon); Lethbridge, May 8, 1923 (H. E. Gray); *Manitoba:* Aweme, June 11, 1909 (E. Criddle); Onoh, June 28, 1922 (N. Criddle); *Montana:* Gallatin County, June 29, 1920; *Wyoming:* Jenny Lake, June, 1941 (G. E. Bohart); *Colorado:* Roggen, May 16, 1931 (H. G. Rodeck); Lamar, June 11, 1919 (T. D. A. Cockerell); West Cliff, (W. H. Ashmead); *Utah:* Trout Creek, May 8, 1934 (C. F.

Smith); *Arizona:* Santa Catalina Mountains, June 28, 1917; *New Mexico:* Lake Burford, June 5, 1916 (A. Wetmore); *Texas:* Milan, May 19, 1918 (A. Wetmore).

The type specimen of *integra* is in the Academy of Natural Sciences of Philadelphia; of *novomexicana* and *florissanticola* in the United States National Museum; of *integra nigrigena* in the Snow Entomological Collections at the University of Kansas.

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PLATE 39

Right mandibles of females, showing the mandibular teeth. The figures are not intended to show an over all mandibular length, but are to be used in comparing length and shape of the teeth, especially the shape of the upper mandibular tooth.

PLATE 39

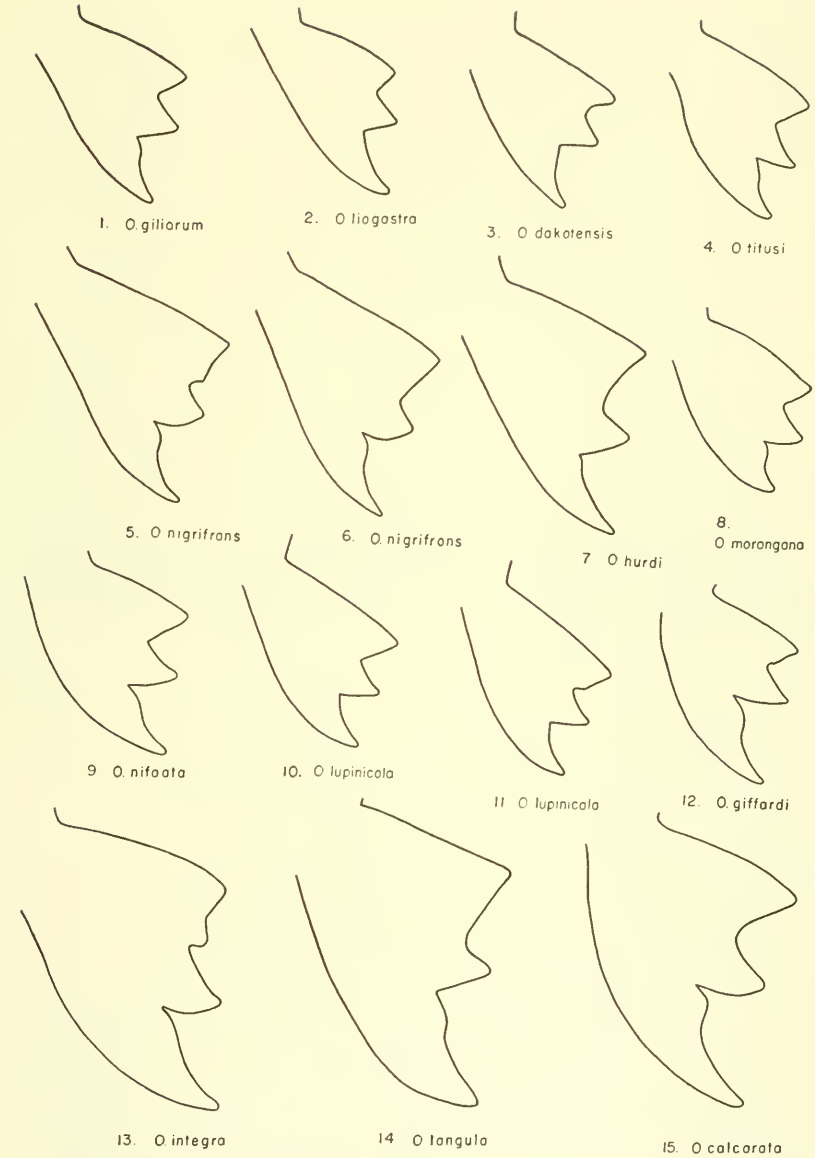

1. O. giliorum
2. O. liogastra
3. O. dakotensis
4. O. titusi
5. O. nigrifrons
6. O. nigrifrons
7 O. hurdi
8. O. morongana
9 O. nifoata
10. O. lupinicola
11 O. lupinicola
12. O. giffardi
13. O. integra
14 O. tangula
15. O. calcarata

PLATE 40

Figures 1 to 6 show the right mandibles of females.

Figures 7 to 18 show the right mandibles of males. The mandibles of the males are drawn in order to show the comparison in shape of the upper tooth and the superior apical angle.

PLATE 40

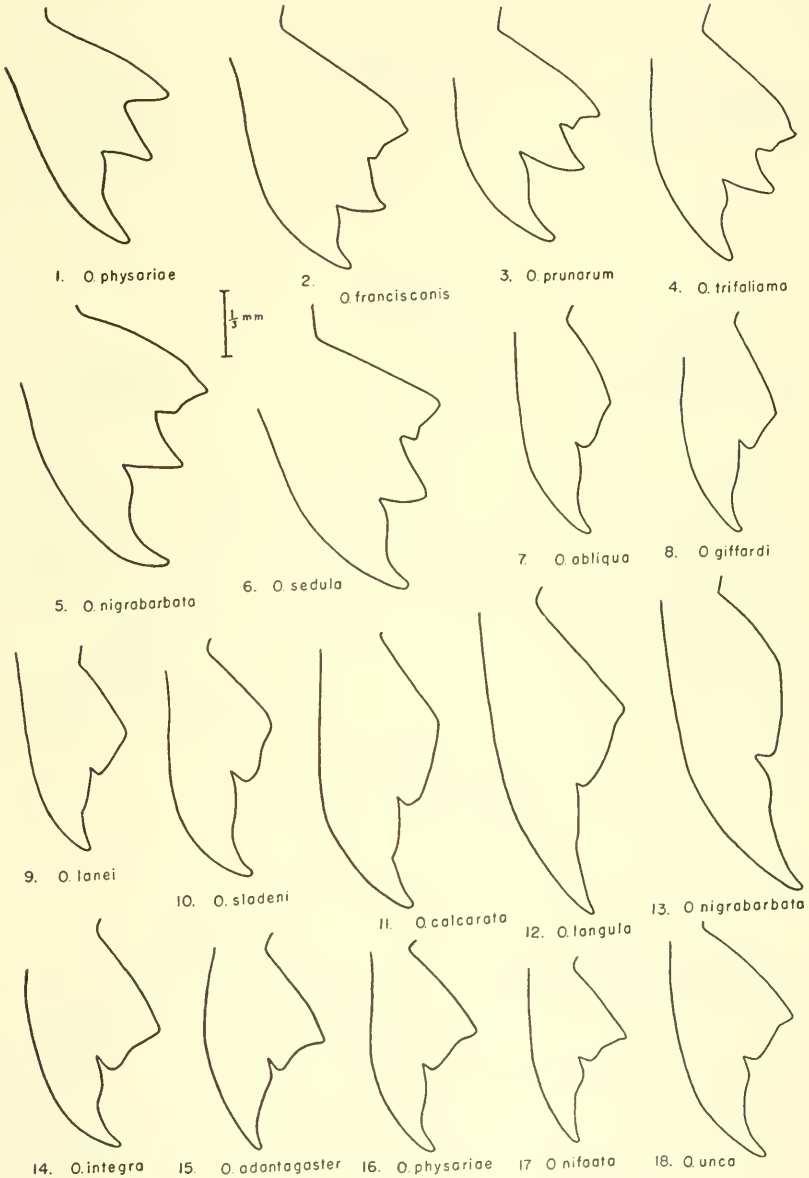

1. O. physariae
2. O. franciscanis
3. O. prunarum
4. O. trifaliama
1/3 mm
5. O. nigrabarbata
6. O. sedula
7. O. obliqua
8. O giffardi
9. O. lanei
10. O. sladeni
11. O. calcarata
12. O. langula
13. O nigrabarbata
14. O. integra
15. O. adantagaster
16. O. physariae
17 O nifaata
18. O. unca

PLATE 41

Fourth metasomal sterna of males, showing ventral surfaces. These figures are given to show the outlines of the sterna, the shapes of the impunctate portions which are surrounded by the median apical bristlelike hairs, and the density of hairs in the lateral patches. No attempt has been made to show the bases of the sterna or the numerous minute hairs on the basal portions of the sterna. The apices of the sterna are placed upward on the plate.

PLATE 41

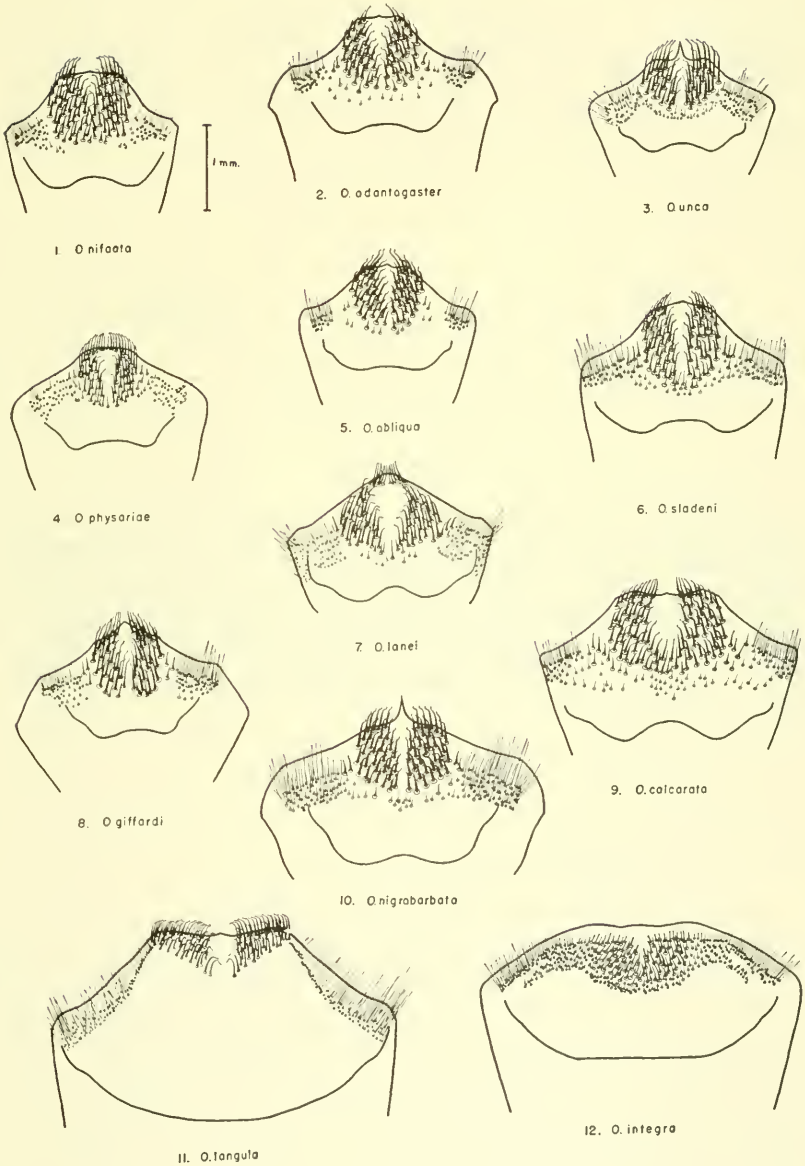

1 mm.
1. O. nifaata
2. O. adantogaster
3. O. unca
4. O. physariae
5. O. obliqua
6. O. sladeni
7. O. lanei
8. O. giffordi
9. O. calcarata
10. O. nigrobarbata
11. O. tangula
12. O. integra

PLATE 42

Sixth sterna of males, showing the ventral surfaces. These figures are given to show the outlines of the sterna, particularly the shape of the median apical produced portion. Only those hairs on the produced portion have been shown, although minute hairs are usually present in the darker parts of the sterna (shown by close stipples), and a thick fimbria of hairs is present mid-basally. Those hairs which have been omitted are apparently of no taxonomic value. The apices of the sterna are placed upward on the plate.

PLATE 42

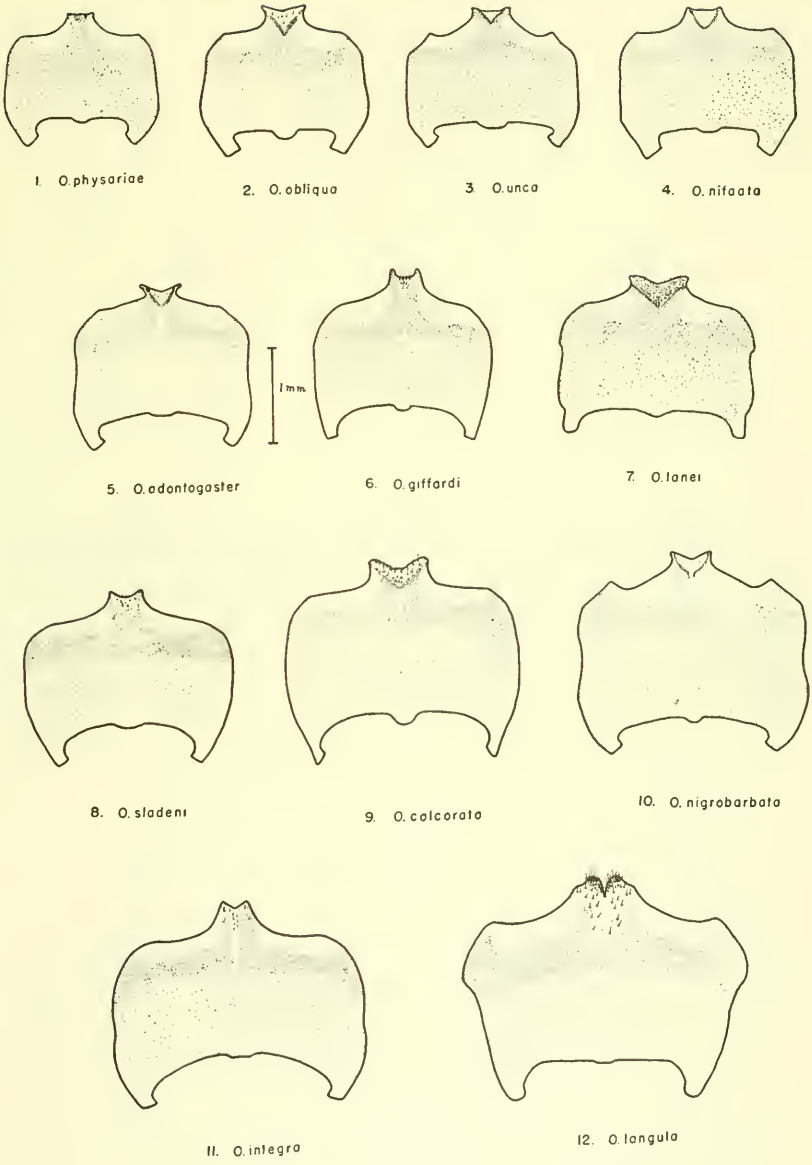

1 mm.
1. O. physariae
2. O. obliqua
3. O. unca
4. O. nifaata
5. O. odontogaster
6. O. giffardi
7. O. lanei
8. O. sladeni
9. O. calcarata
10. O. nigrobarbata
11. O. integra
12. O. langula

PLATE 43

Eighth metasomal sterna of males, showing ventral surfaces. The apices of the sterna are placed upward on the plate. Variability such as that shown for *O. unca* (figs. 1 and 2) occurs also in certain other species.

PLATE 43

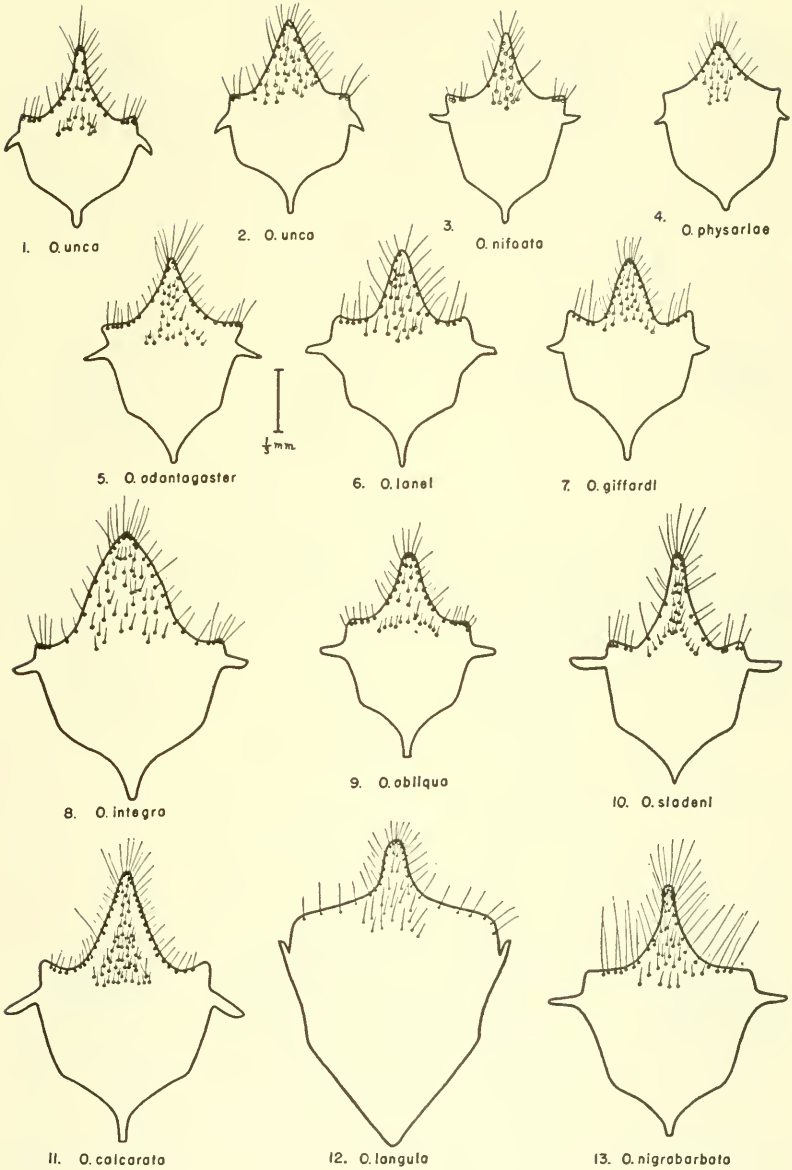
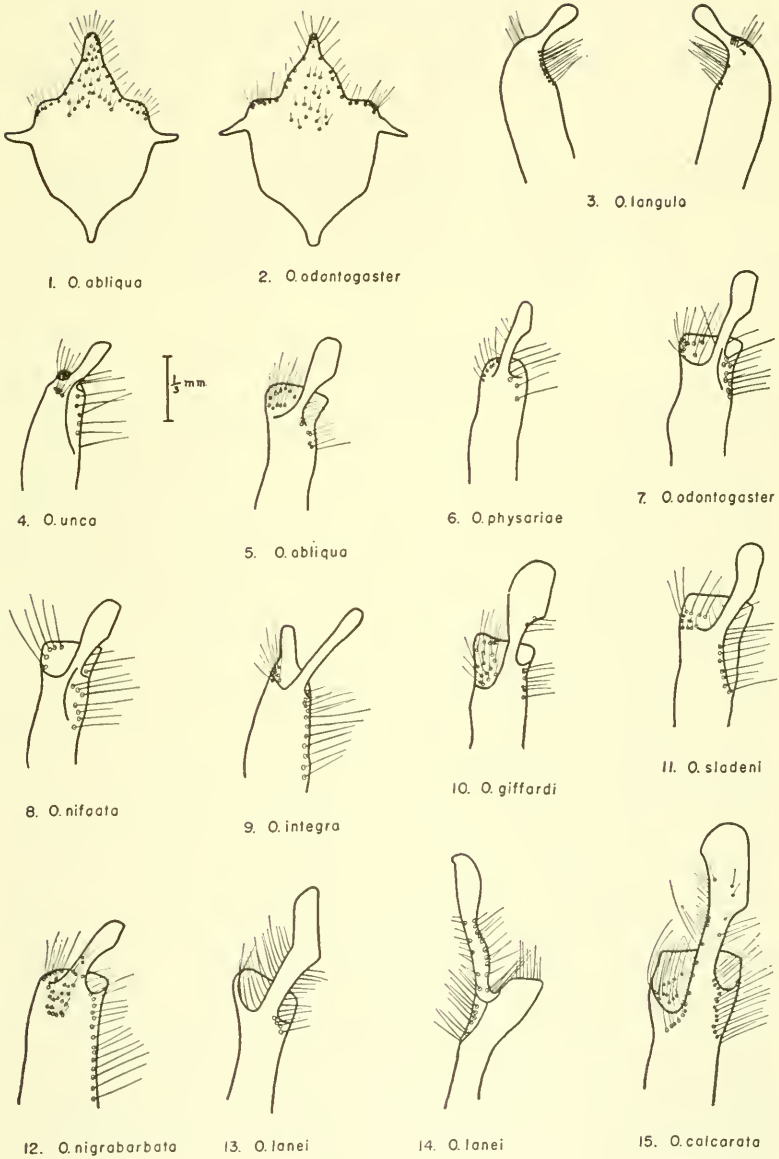

1. O. unca
2. O. unca
3. O. nifoata
4. O. physariae
5. O. odontogaster
1/3 mm
6. O. lanei
7. O. giffardi
8. O. integra
9. O. obliqua
10. O. sladeni
11. O. calcarata
12. O. longula
13. O. nigrobarbata

PLATE 44

Figures 1 and 2 show the eighth sterna of males. Figures 3-15 show the apices of the right gonocoxites of the male genitalia. Both a dorsal and ventral view are shown of *longula* (fig. 3). Figure 14 is a lateral view. Otherwise all figures are ventral views.

PLATE 44


1. O. obliqua
2. O. odontogaster
3. O. langula
4. O. unca
1/3 mm.
5. O. obliqua
6. O. physariae
7. O. odontogaster
8. O. nifoata
9. O. integra
10. O. giffardi
11. O. sladeni
12. O. nigrabarbata
13. O. lanei
14. O. lanei
15. O. calcarata

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A Revision of Some Phlepsiuslike Genera of the Tribe Deltocephalini (Homoptera, Cicadellidae) in America North of Mexico [1]

BY

HAROLD W. CROWDER

ABSTRACT: This paper is a systematic study of the Nearctic leafhopper species which have been described under the European genus *Phlepsius* erected by F. X. Fieber in 1866, or species in other genera thought to be related to the Phlepsiuslike forms. Eight genera in the order discussed, namely, *Texananus, Paraphlepsius, Phlepsanus, Aplanus, Remadosus, Dorydiella, Orientus,* and *Tropicanus,* include 122 species, one sub-species, and two varieties, fifteen species of which are new. The genus *Texananus,* erected by Ball in 1918, is divided into three subgenera, namely, *Texananus* Ball, *Excultanus* Oman and *Iowanus* Ball. In the genus *Texananus,* the twenty-nine following species and subspecies are retained: *Texananus (Texananus) angus, arctostaphylae, areolatus, bialtus, cumulatus, decorus, denticulus, deversus, dolus, extremus, gladius, graphicus, lathropi, latipex, marmor, mexicanus, monticolus, oregonus, ovatus, ovatus* var. *distinctus, pergradus, personatus, rufusculus, sabinus, sonorus, spatulatus, superbus, ultratus,* and *vermiculatus.* The form *Phlepsius cumulatus* var. *arctostaphylae* is raised to specific rank and the species *Phlepsius distinctus* is established as a subspecies of *ovatus.* The following new species of the subgenus *Texananus* are named and described: *Texananus (Texananus) constrictus, extensus, fumosus, proximus, sextus,* and *validus.* In the subgenus *Excultanus* the following four species are retained: *Texananus (Excultanus) dorothyi, excultus, incurvatus,* and *neomexicanus.* In the subgenus *Iowanus* the following five species are retained: *Texananus (Iowanus) bullatus, caducus, dicentrus, lyratus* and *majestus.* The following new species of the subgenus *Iowanus* is named and described: *Texananus (Iowanus) longipennis. Texananus borrori* DeLong is placed in synonomy with *Texananus (Iowanus) majestus* (Osborn and Ball). In the genus *Paraphlepsius,* erected by Baker in 1897, the following fifty-nine species are retained: *Paraphlepsius abruptus, altus, apertus, apertinus, attractus, bifidus, bipartitus, brunneus, carolinus, certus, cinereus, collitus, continuus, dentatus, divergens, eburneolus, electus,*

1. Contribution no. 771 from the Department of Entomology of the University of Kansas.

floridanus, fulvidorsum, fuscipennis, fuscipennis var. *seminolus, hemicolor, humidus, incisus, irroratus, lascivius, latifrons, lippulus, lobatus, macullelus, maculosus, mimus, nudus, obvius, occidentalis, optatus, operculatus, pallidus, palustris, particolor, planus, punctiscriptus, pusillus, rileyi, rossi, siclus, slossonae, solidaginis, strobi, supinus, tennessa, texanus, tigrinus, torridus, truncatus, tullahomi, tubus, turpiculus,* and *umbrosus.* The following new species of the genus *Paraphlepsius* are named and described: *Paraphlepsius acutus, avicephalus, cornutus, excavatus, emarginatus,* and *spinosus.* In the genus *Phlepsanus* erected by Oman in 1949, the following three species and one variety are retained: *Phlepsanus denudatus, denudatus* var. *carpolus, nigrifrons,* and *vanduzei.* The following new species of the genus *Phlepsanus* are named and described: *Phlepsanus angustus* and *tumidatus.* In the genus *Remadosus,* erected by Ball in 1929, the following three species are retained: *Remadosus fumidus, magnus,* and *piceus.* The form *R. magnus* var. *piceus* is raised to specific rank. In the genus *Aplanus* erected by Oman in 1949 the following two species are retained: *Aplanus albidus* and *pauperculus.* In the genus *Dorydiella,* erected by Baker in 1897, the following two species are retained: *Dorydiella floridana* and *kansana.* In the genus *Orientus,* erected by DeLong in 1938, the one following species is retained: *Orientus ishidae.* Finally, in the genus *Tropicanus,* erected by DeLong in 1944, the one following species is retained: *Tropicanus costomaculatus.* A brief comparative description of all species is given and augmented by the descriptions of the male genitalia and the female seventh sternum. Keys to the genera and species are included, and the plates figure the views of the male genitalia and the female seventh sternum. Important synonymy, old and new, is given under the specific names.

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INTRODUCTION

This paper is a revision and systematic treatment of the species of some of the Phlepsiuslike leafhoppers of the family Cicadellidae of America, North of Mexico, and includes the following genera in the order given: *Texananus* Ball, 1918, *Paraphlepsius* Baker, 1897, *Phlepsanus* Oman, 1949, *Aplanus* Oman, 1949, *Remadosus* Ball, 1929, *Dorydiella* Baker, 1897, *Orientus* DeLong, 1938, *Tropicanus* DeLong, 1944.

These genera have been selected from the Tribe Deltocephalini of the Subfamily Deltocephalinae (Oman 1949) on the basis of brownish irrorations and vermiculate or ramose lines within the cells of the elytra, a similarity in fore wing venation, and other similar features of external and internal morphology. With the exception of the genera *Remadosus* and *Dorydiella,* all species have been named or associated with the European genus *Phlepsius* Fieber, 1866. The species of *Dixianus* Ball, 1918, *Josanus* DeLong, 1938, and *Lycioides* Oman, 1949, were originally described in the genus *Phlepsius* but are not included in this paper because of the distinctly different male internal genitalia. It is questionable whether the genera *Dorydiella, Orientus, Tropicanus* and *Remadosus* are closely related. However, due to similar external morphology and coloration they have been included.

Male and female specimens of the European *Phlepsius maculatus* Fieber received from Dr. E. Seguy of the Paris Natural History Museum were examined in relation to American forms to determine whether the name *Phlepsius* should be re-established in place of the name *Texananus.* However, it was thought best to retain *Texananus* for the American narrow-headed forms because of considerable difference in the genitalial characters.

The genus *Texananus* Ball, consisting of the narrow-headed forms, and similar to the European genotype *P. maculatus,* of the genus *Phlepsius,* is divided into the following subgenera: *Texananus* Ball with thirty-four species and one subspecies, *Excultanus* Oman with four species, and *Iowanus* Ball with six species. Of the forty-four species included, seven are new.

The genus *Paraphlepsius* Baker, consisting of the broad-headed forms, contains sixty-four species and one variety, six species of which are new. *Paraphlepsius ramosus* Baker 1897, originally designated as the type for the genus *Paraphlepsius,* was found to be *Paraphlepsius humidus* (Van Duzee) 1892. The genus *Phlepsanus* Oman, with five species and one variety, contains two species which are new. The genus *Remadosus* Ball includes three species. The genus *Aplanus* Oman with two species, the genus *Dorydiella* Baker with two species, the genus *Orientus* with one species, and the genus *Tropicanus* with one species stand without changes.

Approximately 20,000 specimens have been examined including types, paratypes, and specimens compared with types by other workers. With the exception of a few cases mentioned in notes under the description, types were examined or material was compared with

types by eminent authorities. A few types were unfortunately destroyed by the Clemson College fire in 1925, but material compared with types was available in the Ohio State College Collections and other depositories.

The holotypes of *Paraphlepsius docilis* (Van Duzee), and *Texananus delicatus* (Osborn and Lathrop), deposited in the Museum of the California Academy of Sciences were unavailable for study but were examined by Dr. E. S. Ross.

Two other species, *Bythoscopus stipatus* Walker, 1851, and *Bythoscopus auroalbus* Walker, 1851, probably belong to the genus *Paraphlepsius* but their true identity is not known. The types are in the British Museum (Natural History).

The exact position of *Phlepsius fastuosus* Ball is considered in question since it was described from a female taken in New Mexico. It is probably related to or identical with *P. punctiscriptus* (Van Duzee).

In the earlier work the classification was based upon external characters of the head, pronotum, wings, male valve, male plates, and female seventh sternum. However the above external characters are unreliable in some cases due to the tendency for some of the different species of a genus to be much alike in appearance.

The internal genitalia of the male, including the aedeagus and its processes, the connective, and pygofer with its processes, though showing some slight variation in a species, are usually distinct from other related species. Therefore, the species were separated and keys were established mainly on the basis of male genitalia. The female seventh sternum was also found to be diagnostic.

HISTORICAL SYNOPSIS

The genus *Phlepsius* was established by F. X. Fieber in 1866 for European forms with head narrower than pronotum and with forewing cells possessing brownish irrorate, vermiculate, or ramose markings. In America, E. P. Van Duzee in 1892 first published a taxonomic work on American forms, recording eighteen species, thirteen of which were new. In 1897 the genera *Paraphlepsius* Baker and *Dorydiella* Baker were erected. Twenty years later, in 1917, Van Duzee in his catalog recorded sixty-three species and one variety under the generic name *Phlepsius*. He had studied European material for this treatise. E. D. Ball the following year (1918) in recording Mexican and Central American species erected four new subgenera: namely, *Zioninus* with *Phlepsius extremus* Ball as

the type, *Texananus* with *Phlepsius mexicanus* Ball as the type, *Iowanus* with *Phlepsius handlirschi* Ball as the type, and *Dixianus* with *Phlepsius utahnus* Ball as the type. In 1923 Osborn and Lathrop published a synopsis of the genus *Phlepsius,* redescribing, or describing as new, eighty-nine North American species. D. M. DeLong published in the same year host plant studies, and again in 1926 published a paper on food plants of leafhoppers, including many species of *Phlepsius.* Ball, in 1927, published a synonymic study of North American *Phlepsius* species and set up a new subgenus *Pendarus* for the banded forms. DeLong and Caldwell (1937) published a checklist of Cicadellidae of America, north of Mexico, recording sixty-nine species and four varieties of *Phlepsius.* In 1938 the genus *Orientus* and the subgenus *Josanus* were erected by DeLong, and the important work on genitalia of the species of *Paraphlepsius* was published by the same author. In 1944 the genus *Tropicanus* DeLong was established. DeLong and Knull republished the Checklist of the Cicadellidae (Homoptera) of America, North of Mexico in 1945. In 1948 the genus *Iowanus* was revised by DeLong and Hershberger, and in 1949 the genus *Texananus* was revised by the same authors.

The following species, although described under the genus *Phlepsius,* have been removed to other genera not included in this work: *Phlepsius inornatus* Baker to the genus *Acinopterus; Phlepsius josea* Ball to the genus *Idiodonus;* several species of small cicadellids including *Aligia amoena, Phlepsius condalianus, Phlepsius lycioides, Phlepsius loculatus, Phlepsius nevadus, Phlepsius stellaris* are considered now in the new genus *Lycioides* Oman; *Phlepsius utahnus* Ball remains in the *Genus Dixianus. Phlepsius arizonus* Osborn and Lathrop is *Dixianus utahnus* (Ball) and *Phlepsius atropunctatus* DeLong is *Fieberiella flori* Stahl.

The recent generic study on Nearctic leafhoppers by Oman (1949) with checklists of species, established more firmly than before the generic limits based on internal characters of male genitalia as well as on external characters. The genera *Phlepsanus* and *Aplanus* were established in this publication.

External and internal morphological structures and terminology used in this paper are principally in accord with those discussed in Doctor Oman's paper. Characteristic external morphology is represented in my Plate I, and the morphology of the male and female genitalia is represented in Plate II.

PHYLOGENY AND BINOMICS

The Homoptera seems to have reached a maximum in the Permian and even was differentiated in the Upper Carboniferous (Carpenter 1930). According to Evans (1947) it is possible that the Cicadellidae arose as early as the Triassic period but that the recent wide distribution of leafhopper groups came about in the Tertiary time. Evans (1947) states that the oldest known undoubted representative of the family is *Mesojassoides gigantea* Oman (1937) from the Cretaceous of Colorado. The plasticity of leafhoppers to evolve in many directions over the earth was no doubt closely associated with the expansion of the Angiosperms in the Cretaceous times and since. Evans (1947) further suggests that evolutionary development is accompanied by increasing size and that the primitive color is brown, this color being followed successively by green, orange, yellow, red, black and white. One would conclude from the above that the species of the genera *Texananus, Paraphlepsius* and other related genera in this investigation are primitive in coloration but that their large size would seem indicative of specialization.

As the eggs of leafhoppers are inserted in the plant tissues, the life cycle is governed considerably by the development of the host plant. Plants other than the regular host plants may be used as food so that adults may be swept from various plants. Species of the genus *Texananus* live on herbaceous dicotyledons as do most of the species of the genus *Paraphlepsius,* with exception of a few which live on oaks. Oman (1949) mentions the presence of a Y-shaped connective in many forms of the Deltocephalini and associates this feature with the dicotyledons as host plants. This character is found consistently in the groups of the present study. In like manner the linear connective, with arms closely paralleling each other and fusing often at the apex, is characteristic of the forms found on grasses. Apparently no grass feeding forms are in the present study. However, the species *Texananus* (*Texananus*) *areolatus* (Baker), *Texananus* (*Texananus*) *fumosus* n. sp., and *Texananus* (*Texananus*) *extremus* (Ball) approach this form of connective in the slender parallel arms but apparently without the fusion at their apex. Oman (1949) further states that it is his belief that the linear or deltocephaline type of connective is a specialization of the Y-shaped or eusceline type and the connectives have gradually become fused at least at their apices. It would be interesting to determine the host plants of the above mentioned

species since they may represent a transition from the Y-shaped type to the linear fused type.

Such studies suggest that further investigation into the morphological structures of leafhoppers as associated with feeding habits and life cycle will better establish taxonomic procedure on the basis of true phylogenetic relationships.

Synopsis of the TRIBE DELTOCEPHALINI Oman

Tribe Deltocephalini Oman, Memoirs of Ent. Soc. Washington, No. 3, 1949, p. 108.

Described as follows:

"Head usually not strongly produced and ocellus usually close to eye; genae not broadly expanded. Species either macropterous, subbrachypterous, or brachypterous; if macropterous the commissural margin of forewing not forming a straight line to apex of wing and outer anteapical cell usually present. Lateral margins of pronotum usually short and not or but feebly carinate. Hind basitarsus not sulcate."

KEY TO THE GENERA OF PHLEPSIUSLIKE SPECIES

1.	Head distinctly narrower than pronotum	2
	Head as wide as, or wider than pronotum	3
2.(1)	Crown with transverse sulcus. Male pygofer with blade-like pygofer hook on inner surface below dorsal margin. Plates without setae	*Orientus*
	Crown without transverse sulcus. Male pygofer usually without pygofer hooks. Plates with setae	*Texananus*
3.(1)	Crown very broad, its anterior margin paralleling posterior margin. Ocelli large, their distance from eyes about two and one-half times their own diameter	*Remadosus*
	Crown of head not extremely broad, with median length longer than that next to eye. Ocelli near eyes a distance of less than two and one-half times their own diameter	4
4.(3)	Anterior margin of head bluntly rounded, crown convex. Without male pygofer hooks or processes	5
	Anterior margin of head usually delimited, angled or subfoliaceous, crown frequently concave or with transverse depression. If crown is bluntly rounded with front, male pygofer with projected hooks or beaks	6
5.(4)	Clypeus as broad as long. Connective shaft extending posteriorly well beyond aedeagal articulation. Robust forms,	*Phlepsanus*
	Clypeus much longer than wide. Connective shaft apex articulated with aedeagus. Dark arcuate dash near middle of clavus	*Tropicanus*
6.(4)	Anterior margin of head foliaceous. Apex of forewing acuminate	*Dorydiella*
	Anterior margin of head not foliaceous. Wing not acuminate,	7

7.(6) Anterior margin of head often angled with front, sometimes subfoliaceous; if rounded with front, hooks or beaks usually present on male pygofer. Length of body greater than 4 mm. and coloration brownish ..... *Paraphlepsius*

Anterior margin of head rounded. Pygofer hooks absent. Length of body only 4 mm. or less and coloration whitish, *Aplanus*

Synopsis of the GENUS TEXANANUS Ball

Phlepsius subgenus *Texananus* Ball, Ann. Ent. Soc. Amer., vol. 11, 1918, p. 388.
Phlepsius subgenus *Zioninus* Ball, Ann. Ent. Soc. Amer., vol. 11, 1918, p. 388. Type by original designation *Phlepsius extremus* Ball, 1901.
Texananus subgenus *Aridanus* DeLong, Ohio Jour. Sci., vol. 49, 1949, p. 173.

Originally described as follows:

"Resembling *Phlepsius* but with head narrower than the pronotum, front rather broad, convex, widening above the antennae and approaching the eyes. Vertex bluntly conical, the margin to the front rounding. Pronotum large, broadly and evenly rounding in front; the lateral margin long, oblique, and definitely carinate. Elytra broader and shorter than in *Iowanus*, whole surface inscribed with vermiculate lines. Type of the subgenus *Phlepsius* (*Texananus*) *mexicanus* n. sp."

Crown usually convex; face long, clypeus narrow; forewing appendix well developed, inner apical cell opened basally; male plates triangular, spinelike setae uniseriate; connective Y-shaped with a posterior single or double projection beyond the aedeagal articulation; aedeagus simple or with ventral accessory process; pygofer setose, usually without pygofer hook from margins.

KEY TO THE SUBGENERA OF TEXANANUS BALL

1. Connective not extended caudally beyond aedeagal articulation except possibly as a small lobe. Female seventh sternum deeply and roundly excavated almost to base with edges of underlying pair of membranes showing beyond excavation margin ..... *Excultanus*

Connective shaft extended caudally beyond aedeagal articulation as a single or double apical portion. Female seventh sternum variable but not broadly excavated almost to base and without the underlying membranes showing beyond excavation 2

2.(1) Male pygofer with posterior margin developed into a lobe. Near base of lobe on inner pygofer margin a pygofer hook curves mesad within capsule. Female seventh sternum with narrow deep median notch about half way to base .... *Iowanus*

Posterior margin without lobe or pygofer hook. Female seventh sternum variable but usually not with a deep narrow median notch ..... *Texananus*

Synopsis of the Subgenus TEXANANUS Ball

References for synonomy and typical subgenus under generic heading.

Characters in generic description and in subgeneric key.

KEY TO THE SPECIES OF TEXANANUS (TEXANANUS) BALL

1. Ninth segment in ventral view with pair of plates and a triangular valve (male) 2
   Ninth segment in ventral view with pygofers closely adjoining narrow median ovipositors (female) 36
2.(1) Connective shaft divided into paired processes near aedeagal articulation 3
   Connective shaft as a single median process beyond articulation, excepting short basal processes 11
3.(2) Length of male plates on median line at least twice that of valve 4
   Length of plates on median line less than twice that of valve 7
4.(3) Aedeagal shaft apex curved posteriorly. Apical two thirds of plate very slender and tapering to sharp apex ..... 1. *ultratus*
   Aedeagal shaft apex tapering and directed dorsad. Apical two thirds of plate not extremely slender 5
5.(4) Plates tapering to slender apex from wider basal third. 2. *spatulatus*
   Plates narrowed on basal third to a rather parallel-sided apical two thirds, apices rounded 6
6.(5) Broad irregular black broken band between eyes .... 3. *sabinus*
   Crown without black band, irrorate ..... 4. *personatus*
7.(3) Connective ventral shaft processes with apices turned ventrad beak-like. Plates triangular, outer margin almost straight ..... 5. *rufusculus*
   Connective ventral shaft processes not as above. Plates short and rounded on lateral margins 8
8.(7) Connective ventral shaft in lateral view formed into pair of long arching hooks with ventral processes on their middle ..... 6. *vermiculatus*
   Connective ventral shaft with nearly straight processes 9
9.(8) Connective ventral shaft processes in lateral view expanding fanlike ..... 7. *oregonus*
   Connective ventral shaft not as above 10
10.(9) Connective ventral shaft processes in lateral view tapering on apical third as they curve slightly ventrad to sharp apex ..... 8. *angus*
   Connective ventral shaft processes similar to above but apical two fifths of processes contracted dorsally to a tapering rather straight apical portion ..... 9. *superbus*
11.(2) Outer margin of apex of style longest in dorsoventral view .. 12
   Inner margin of style in dorsoventral view longest, or apex rounded or truncate 13

12.(11) Ventral shaft slender, curving uniformly and slightly dorsad from base ..... 10. *lathropi*
Ventral shaft tapering, proximal three fourths straight, apical fourth strongly curved dorsad ..... 11. *extensus*
13.(11) Connective ventral shaft with pair of short basal spines in dorsal view ..... 12. *mexicanus*
Without short basal spines on connective ventral shaft 14
14.(13) Aedeagal shaft in lateral view widened on outer half, apical portion bifid ..... 13. *latipex*
Aedeagal shaft not bifid as above 15
15.(14) Aedeagal shaft very short, apical half not strongly tapering to apex. Inner margin of plate at apex constricted 16
Aedeagal shaft tapering strongly to apex, sickle-shaped. Inner margin of plate less constricted 18
16.(15) Connective ventral shaft apex avicephaliform in lateral view. 14. *aerolatus*
Connective ventral shaft not avicephaliform 17
17.(16) Ventral shaft tapering to apex from its base in lateral view, 15. *extremus*
Ventral shaft apical half slightly widened in lateral view, 16. *fumosus*
18.(15) Basal three fourths of ventral shaft straight with apex curved ventrally or apex at ventral margin 19
Ventral shaft in lateral view curving dorsad in some region 22
19.(18) Apices of styles turned outward 20
Apices of styles turned inward 21
20.(19) Lower margin of ventral shaft straight, upper margin sloping to lower margin to form a pointed apex ..... 17. *dolus*
Ventral shaft tapering to a very slightly turned up sharp point. Apex of style narrowly lobed ..... 18. *sonorus*
21.(19) Apical portion of ventral shaft slightly curved ventrad then posteriorly ..... 19. *decorus*
Apical portion of ventral shaft curved strongly ventrad then posteriorly to a point ..... 20. *deversus*
22.(18) Ventral shaft very slender, almost hairlike ..... 21. *pergradus*
Ventral shaft not slender or hairlike 23
23.(22) Ventral shaft with pair of subapical teeth 24
Ventral shaft without subapical teeth 25
24.(23) Pygofer uniformly narrowed posteriorly from anterior margin, with rounded posterior margin. Coloration light brown, 22. *ovatus*
Pygofer narrowed on posterior third, posterior margin rather truncate. Coloration dark brown to black, 23. *ovatus* subsp. *distinctus*
25.(23) Ventral shaft curved slightly dorsad, tapering from its base to a posteriorly directed short apex 26
Ventral shaft curved slightly dorsad to sharpened apex or swollen apical portion in lateral view 27
26.(25) Proximal portion of ventral shaft in lateral view broad, tapering to posteriorly directed apical sixth ..... 24. *sextus*

Proximal two thirds of ventral shaft in lateral view only very slightly tapering, apical fourth curved strongly dorsad then abruptly posteriorly to a point ..... 25. *gladius*

27.(25) Apical portion of ventral shaft curved dorsad and slightly swollen in lateral view 28

Apical portion of ventral shaft not swollen 32

28.(27) Ventral shaft stout, slightly swollen on apical third or half in lateral view 29

Ventral shaft slender, swollen on apical fourth in lateral view, 31

29.(28) Ventral shaft only very slightly curved dorsally, saber-shaped. Connective arms short ..... 26. *denticulus*

Not saber-shaped. Connective arms relatively long 30

30.(29) Plates relatively sharp pointed at apex ..... 27. *graphicus*

Plates bluntly rounded at apex ..... 28. *constrictus*

31.(28) Posterior apex of pygofer directed upward. Inner margin of male plates curving out, outer margin straight 29. *marmor*

Posterior apex of pygofer not directed upward. Inner margin of male plates straight, outer margin roundingly curved, 30. *cumulatus*

32.(27) Ventral shaft almost uniform size to short tapering apex 33

Ventral shaft in lateral view progressively tapering as it curves dorsally in varying degrees 34

33.(32) Ventral shaft only slightly curved dorsad ..... 31. *arctostaphylae*

Ventral shaft apical two fifths curved strongly dorsad, 32. *monticolus*

34.(32) Apex of ventral shaft rapidly curved dorsad on apical half. Median length of plate about half valve length ..... 33. *proximus*

Apex of ventral shaft not radically curved dorsad. Plate median length almost equals valve length 35

35.(34) Width of connective shaft at articulation not more than width of base of aedeagal shaft in lateral view ..... 34. *bialtus*

Width of connective at articulation about twice width of aedeagal shaft base ..... 35. *validus*

36.(1) Female seventh sternum with lateral margins rapidly converging from base to a median posterior lobe ..... 12. *mexicanus*

Lateral margins of seventh sternum not converging to median lobe 37

37.(36) Posterior margin of seventh sternum with four toothlike median lobes of about equal length between lateral angles, 26. *denticulus*

Less than four lobes between lateral angles 38

38.(37) Posterior middle of seventh sternum concave, with pair of lobes separated by a narrow or small notch 39

Without median lobes separated by a narrow notch 42

39.(38) Median lobes of seventh sternum produced beyond lateral angles, the narrow median notch deeper than lateral concavities ..... 3. *sabinus*

Lobes not produced beyond lateral angles 40

40.(39) Lobes of seventh sternum separated by a V-shaped notch slightly deeper than lateral concavities, lobe apices darkened ..... 2. *spatulatus*
Lobes small, separated by a small notch, lobes not darkened, 41
41.(40) Posterior margin of seventh sternum slightly concave with distinct small lobes, lateral margins broadly rounded, 5. *rufusculus*
Posterior margin strongly concave with indications of median lobes, lateral margins almost parallel ..... 15. *extremus*
42.(38) Posterior margin of seventh sternum slightly concave, or truncate with small median notch 43
Posterior margin broadly excavated or notched 45
43.(42) Seventh sternum with lateral margins rounded. Elytra coloration vermiculate ..... 4. *personatus*
Posterior half of lateral margin of seventh sternum concave or straight. Elytra coloration areolate 44
44.(43) Seventh sternum yellowish with light colored markings and dorsum of body brownish yellow ..... 14. *areolatus*
Seventh sternum with irregular dark markings and dorsum distinctly dark ..... 16. *fumosus*
45.(42) Seventh sternum broadly excavated between lateral angles, often with a median secondary excavation, sometimes corners of median excavation produced even with or beyond lateral angles 46
Seventh sternum not excavated from lateral angles, posterior opening of excavation usually not more than half that of width between lateral angles 56
46.(45) Seventh sternum posterior margin roundly and broadly excavated almost to base without secondary median excavations ..... 6. *vermiculatus*
Posterior margin with secondary excavations 47
47.(46) Seventh sternum with posterior corners of median secondary excavation acute 48
Seventh sternum with excavation margins sloping sinuously from lateral angles to bottom 49
48.(47) Posterior corners of broad V-shaped secondary excavation produced even or beyond lateral angles ..... 11. *extensus*
Posterior corners of secondary quadrangular excavation sharp and slightly posterior to lateral concavities ..... 10. *lathropi*
49.(47) Secondary excavation bottom broadly rounded or almost truncate 50
Secondary excavations consisting of V-shaped notch or with tertiary excavation 52
50.(49) Secondary excavation bottom broadly truncate, or nearly so, 9. *superbus*
Bottom of secondary excavation rounded 51
51.(50) Secondary excavation bottom narrowly rounded, reaching almost two thirds distance to base ..... 8. *angus*
Secondary excavation bottom broadly rounded, reaching about half way to base ..... 7. *oregonus*

52.(49) Primary excavation with secondary V-shaped median notch, 53
Secondary excavation with a tendency toward a narrow tertiary excavation 54
53.(52) V-shaped notch at bottom of excavation reaching almost to base ..... 20. *deversus*
Notch small at bottom, ending near middle of segment, 13. *latipex*
54.(52) Depth of total excavations at notch not more than half way to base. Seventh sternum length about one third width, 21. *pergradus*
Depth of total excavation more than half way to base. Length of seventh sternum only about fourth of width .. 55
55.(54) Dorsum of body with light brown vermiculate lines . 22. *ovatus*
Coloration of dorsum of body consisting of nearly black markings on ivory background .... 23. *ovatus* subsp. *distinctus*
56.(45) Excavation semicircular or with a rather truncate bottom .. 57
A primary excavation with a deep median V-shaped or U-shaped secondary excavation 59
57.(56) Posterior margin of seventh sternum with a semicircular median excavation ..... 25. *gladius*
Posterior margin of seventh sternum with a semicircular excavation, and a secondary notch 58
58.(57) Seventh sternum mostly light colored anterior to dark border, 35. *validus*
Seventh sternum with dark areas anterior to dark border, 24. *sextus*
59.(56) Excavation margins sloping sinuously to bottom 60
Excavation margin angulate by reason of posterior sharpened corners of median secondary excavation 61
60.(59) Secondary excavation broadly U-shaped ..... 17. *dolus*
Secondary excavation, if present, V-shaped ..... 19. *decorus*
61.(59) Primary excavation half as long or longer than secondary excavation 62
Primary excavation as small lateral notches, less than half as long as secondary excavation 63
62.(61) Secondary excavation almost twice as deep as primary excavation ..... 32. *monticolus*
Secondary excavation about as long as depth of primary excavation ..... 27. *graphicus*
63.(61) Trilobed commissural line distinctly ivory white .... 29. *marmor*
Trilobed commissural line not distinct 64
64.(63) Dorsum of body light brown ..... 30. *cumulatus*
Dorsum of body dark brown. Purplish markings on legs, 31. *arctostaphylae*

1. *Texananus* (*Texananus*) *ultratus* DeLong

Texananus ultratus DeLong, Bull. Brooklyn, Ent. Soc., vol. 38, 1943, p. 126.

Resembling *spatulatus* in form and coloration but with vertex broadly rounded and plates extremely long and slender, gradually tapering to their slender apices.

Genitalia: Female as yet not known. Male in lateral view: Pygofer elongate, narrowing posteriorly to a rounded posterior margin and with anterior margin sloping dorsoposteriorly, its greatest width five twelfths its length. Aedeagal base almost horizontal, sinuous, length three fourths aedeagal length, preatrium short and narrow; aedeagal shaft with basal depth of one sixth base length, posteriorly directed from anterior base portion and tapering as it curves upward dorsoposteriorly to a ventrally curved apical tip. Connective ventral shaft consisting of long pair of posteriorly directed processes. In dorsal view: Aedeagus much wider basally than along slightly tapering shaft. Connective Y-shaped with stout arms apically sharpened; shaft rather wide from arm base to articulation, slender tapering processes crossing each other; shaft length three and one-half times arm length.

Types: Holotype male labeled Arkansas, and paratype male labeled Arizona, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: Only type material.

Notes: Range known to be in Oklahoma and Arizona.

2. *Texananus* (*Texananus*) *spatulatus* (Van Duzee)

Phlepsius spatulatus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 78.

Resembling *sabinus* but with transverse band on crown more irregularly broken and lighter in color; male plates more uniformly narrowing to apices from their broad bases; the posterior median lobes of female seventh sternum only moderately produced.

Genitalia: Female seventh sternum slightly more than one-third as long as wide, lateral margins converging from base, posterior lateral angles rather strongly produced, middle of posterior margin produced into a pair of rather acute lobes separated by a slender V-shaped notch. Male in lateral view: Pygofer parallelogram in shape, upper margin most posterior and gently sloping downward on posterior half. Aedeagal base horizontal, its length seven ninths aedeagal length; aedeagal shaft with basal depth of fifth base length, posteroventrally directed from anterior part of base, gradually tapering as it curves posteriorly and dorsad to a sharpened point. Connective ventral shaft posteroventrally directed and dividing near articulation into a pair of slender tapering processes, entire length one fourth longer than aedeagus. In dorsal view: Aedeagus widest on anterior half of base, narrowing posteriorly, shaft slender and tapering to apex. Connective Y-shaped with arms narrowing apically; shaft widest at articulation, narrowed

posteriorly and divided into slender processes which either diverge or cross each other.

Types: Lectotype female, "Texas, Aaron, Type" designated by Dr. P. W. Oman in Iowa State College Entomological Collections. One female syntype labeled "Texas, Aaron" in same collections. Types studied.

Material studied: (Montana) Yellowstone Co.; (Utah) Pintura, Aug. 11, Hurricane, Aug. 12, Richfield, Salt Lake, Riverdale, Aug. 9, Ask Creek, June 25, Clinton, July 20, Farmington, July 26, Caliente, San Bernardino, Granite, July 14, Aug. 2, Nov. 25, Moab, July 26, St. George, April 14, Santa Clara, June 10, Kaysville, Zion Nat. Park, Aug. 13; (Nevada) Overton; (Kansas) Reno County, Stafford Co., Thomas Co., Medora, July 2, Saline Co., Norton Co.; (Oklahoma) Comanche Co., June 6, Guymon, June 21; (Texas) Three Rivers, Valentine, Seguin, June 26, Hidalgo, Dec. 28, Palopinto Co., July 14, San Saba Camp, San Juan, Brownsville, Cameron Co., Aug. 3, Pearsall, April 14, Alpine, Concan, Karnes Co., Jackson Co., Aug. 9, Cisco, June 19, Big Springs, June 20, Mission, Dec. 26, Taylor, Brazos Co., Victoria, Marathon; (Colorado) Ft. Collins, June 11; (New Mexico) Tularosa, July 1, Hope, White City, Malaga, July 11, Eddy Co., July 10, Albuquerque; (Arizona) Patagonia, June 24, Tucson, May 3, June 28, Oct. 19, Vail, July 18, Ruby, July 27, Douglas, Aug., Baboquivari Mts., Arivaca, July 26, Nogales, Sept. 19, Santa Catalina Mts., June 19, Phoenix, Maricopa Co., Santa Rita, Granite, Willton, Apr. 15, Glendale, La Osa R., Santa Cruz Valley, Sept. 6, Dills, Chiricahua Mts., July 4, 15, Sacaton, June 17; (California) Redding, June 28, Campo, Aug. 11, Dulzura, El Centro, July 24, Boulevard, Davis, San Diego Co., July 4, Orange Co., Holtsville, Fresno, July 17, LaJolla, July 17, Escondido, July 17, Kerneville, July 24, Mint Canyon, Needles, June 22.

Notes: Range, in Southwest and northward along the Rockies. Desert forms are smaller and paler than mountain or plains forms (Ball 1931). Found on dewberries at Granite, Utah, in August.

3. *Texananus* (*Texananus*) *sabinus* (Sanders and DeLong)

Phlepsius sabinus Sanders and DeLong, Pennsylvania Dept. Agri. Bur. Plant Indust. Bull. 346, vol. 3, 1920, p. 15.

Resembling *spatulatus* in body form and coloration but with a black transverse band on crown; plates with apical two thirds much narrower than basal third and almost parallel sided; median lobes of seventh sternum of female considerably produced beyond the posterior lateral angles.

Genitalia: Female seventh sternum half as long as wide, lateral margins slightly converging from base, posterior lateral angles scarcely produced, middle third of posterior margin strongly produced into two narrow lobes separated by a deep incision. Male in lateral view: Pygofer somewhat parallelogram in shape, upper margin more posterior, upper marginal posterior half sloping downward posteriorly, making a short posterior margin, greatest width about half length. Aedeagal base about horizontal, length about three fifths aedeagal length, preatrium short; aedeagal shaft with depth one fourth base length, directed posteroventrally and tapering as it curves posteriorly and upward in uniform curvature to a narrow apex. Connective ventral shaft consisting of a pair of slender posteriorly directed processes, their length about a fourth longer than aedeagal length. In dorsal view: Aedeagus roundly broad at base reducing to a slender stout shaft posteriorly which tapers slightly to apex. Connective Y-shaped with arms narrowed apically toward inner margin; shaft broad at articulation then suddenly narrowing as it splits into the paired slender processes which may either diverge or cross each other proximally, shaft length about twice arm length.

Types: Three female types, Sabino Canyon and Santa Catalina Mts., Arizona, May 20, and June 29, 1919, W. D. Edmonston, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Texas) Brownsville, June 29; (Arizona) Mescal, July 23, Tucson, Aug. 16, Miami, July 22, Ruby, July 27.

Notes: In Arizona and eastward to Texas.

4. *Texananus* (*Texananus*) *personatus* (Baker)

Phlepsius personatus Baker, Canad. Ent., vol. 30, 1898, p. 30.

Resembling *spatulatus* but with smaller and narrower body and with coloration of faint irrorations; plates with apical two thirds almost parallel sided to a rounded apex; posterior border of female seventh sternum nearly truncate with a V-shaped median notch.

Genitalia: Female seventh sternum half as long as wide, lateral margins roundly and moderately converging from base, lateral angles not produced, posterior margin roundly truncate with a rather deep median V-shaped notch with dark areas on either side of corners of notch. Male in lateral view: Pygofer elongate, anterior margin sloping posteriodorsally, posterior half narrowed somewhat to a rounded margin its greatest width about half its length. Aedeagal base dorsoposteriorly directed, its length about two thirds

length of aedeagus, aedeagal shaft with basal width of about one fifth base length, posteriorly directed from lower basal portion, tapering as it curves dorsally to the apex.

Types: Holotype, Yuma, Ariz., July 6, 1897, Prof. A. P. Morse, in the collection of C. F. Baker deposited in the U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (Arizona) Santa Rita Mts., May 13.

Notes: Range, in mountains of Arizona. This species appears related to *T. spatulatus* in body form but is smaller and lighter in coloration.

5. *Texananus* (*Texananus*) *rufusculus* (Osborn and Lathrop)

Phlepsius rufusculus Osborn & Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 340.

A rather distinct form, somewhat similar to *mexicanus* in body form but with reddish tinge in the coloration; plates similar to those of *mexicanus* but aedeagus and connective more similar to those found in the *spatulatus* group.

Genitalia: Female seventh sternum about one third as long as wide, lateral angles roundly and rather strongly converging posteriorly, posterior lateral angles slightly produced about even with the pair of small median lobes separated by a median notch. Male in lateral view: Pygofer somewhat rectangular, dorsal margin convex, posterior margin sloping dorsoposteriorly from lower margin to a broad roundly blunt apex. Aedeagal base almost horizontal, its length about half aedeagal length, anterior marginal half extends along a preatrium to articulation; aedeagal shaft departing obliquely from base and posteriorly, with basal width of fourth base length, tapering as it curves dorsad at almost right angles as a rather straight apical half. Connective ventral shaft as a pair of posteriorly directed processes, their short blunt apices curved abruptly ventrad. In dorsal view: Aedeagus broad rounded, bulbouslike at base, rapidly narrowing as a slender shaft. Connective oddly Y-shaped with arms broad at their base; shaft on basal fourth as broad as arms at middle, roundly narrowing anterior to articulation, widening at articulation to sharp corners, then narrowing on apical half to about middle of aedeagus where it divides into diverging processes with their apices turned inward.

Types: Holotype female, West St. Louis, Mo., W. V. Warner, and male allotype, Portsmouth, Ohio, C. J. Drake, deposited in the Ohio State University Entomological Collections. Types studied.

Material studied: (Missouri) Platte City, Apr. 27, Jefferson City, Oct. 21; (Arkansas) Polk Co., Dec. 19; (Louisiana) Caddo Parish, Dec. 23.

Notes: Range, in east central states and southward.

6. *Texananus* (*Texananus*) *vermiculatus* DeLong

Texananus vermiculatus DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 42.

Resembling *superbus, angus* and *oregonus* in external form and coloration but distinct in the long pair of curved forked processes of the connective ventral shaft and the moderately narrow and deep excavation of the female seventh sternum.

Genitalia: Female seventh sternum about five-twelfths as long as wide, lateral margins converging from base to rounded posterior lateral angles, posterior margin deeply and broadly excavated three-fourths distance to base. Male in lateral view: Pygofer somewhat rectangular, upper margin sinuous, posterior margin sloping dorsoposteriorly from lower corner to a slightly upturned upper rounded corner. Aedeagal base dorsoposteriorly inclined, its length about three sevenths aedeagal length; aedeagal shaft departing lower basal half posteriorly tapers as it curves dorsally on proximal fourth and slightly curves anteriorly on apical fourth. Connective ventral shaft consists of a pair of long arching hooks, their apices curving ventrally and slightly anteriorly to a point, a slender ventral projection on their middle. In dorsal view: Aedeagus broadly rounded anteriorly, apodemes prominent, reducing rapidly on basal third to the slender shaft. Connective somewhat Y-shaped, arms on anterior half sinuously separating; shaft divided near articulation into diverging posterior processes, their apices and middle accessory processes curved inward.

Types: Holotype male, allotype female, and paratypes, Chiricahua Mts., Arizona, July 14, 1936, J. N. Knull; paratypes, Davis Mts., Texas, August 22, 1936, Tucson, Arizona, July 27, 1936, and Wickenburg, Arizona, July 8, 1937, J. N. Knull. All types deposited in the collection of Dr. D. M. DeLong. Types studied.

Material studied: (New Mexico) White Sands, June 27; (Arizona) Baboquivari Mts., July 24, Tucson, May 26, July 7, Aug. 16, Sept., Santa Rita, Aug. 1, Sacaton, July 10, Tubac, Aug. 21, Pearce, Aug. 23, Ajo, July 23, Chiricahua Mts., July 4, Douglas, July 8, Mustang, June 12, Patagonia, Aug. 21, Arivaca, July 26.

Notes: Range southern Arizona. This form belongs to a group of four similar species including *superbus, angus* and *oregonus.*

7. *Texananus* (*Texananus*) *oregonus* (Ball)

Phlepsius oregonus Ball, Pan-Pacif. Ent., vol. 8, 1931, p. 85.
Texananus manus DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 42.

Resembling in external form and coloration the species *superbus, angus* and *vermiculatus* but distinct in the shape of the broad fan-shaped pair of processes of the connective ventral shaft and in the moderately broad, rounded, and shallow secondary excavation of the female seventh sternum.

Genitalia: Female seventh sternum one third as long as wide, lateral margins strongly converging from base, posterolateral angles rather acute, their inner margins continuous with a wide rounded excavation half way to base. Male in lateral view: Pygofer somewhat rectangular, its posterior margin rounded, greatest depth about three fourths length. Aedeagal base about horizontal, its length half aedeagal shortest length, preatrium long; aedeagal shaft with basal depth of third base length, posteriorly directed on its proximal two fifths, then curving upward and anteriorly in a slender distal portion. Connective ventral shaft as a pair of broad fanlike processes in lateral view, with several teeth at apex, longer teeth at upper and lower margins with shorter teeth between. In dorsal view: Aedeagus widest at base, gradually narrowing along shaft to the apex. Connective hardly Y-shaped with slender arms paralleling each other; shaft base near aedeagal articulation bulbous, giving rise to diverging slender shafts with lateral short teeth at their base, shaft length on median line about equalling arm length.

Types: Holotype female, allotype male and four paratypes, Medford, Oregon, August 14; one paratype, Wenatchee, Washington, August 18; one paratype, Santa Margarita, California, August 6; four paratypes, Pasadena, California, in June; two paratypes, Ti Juana, Mexico, June, E. D. Ball. All above types in collection of E. D. Ball deposited in the U. S. National Museum. Paratype female, Medford, Oregon, E. D. Ball, deposited in Snow Entomological Collections, University of Kansas.

Material studied: (Washington) Satus Pass, July 9; (Oregon) Medford, Aug. 12; (Arizona) Huachuca Mts., July 18, Santa Rita, Ruby, July 22, Baboquivari, Atascosa Mts.; (California) Jamesburg, Aug. 11, Lafayette, July 14, Irving Park, Aug. 4, Leona Heights, July 15, Monterey, July 29, Mt. Springs, July 25, Alemedo, July 19, San Diego, July 5, Dales, Alpine, July 19, Dalzura, Aug. 9, Stinson Beach, Santa Rosa, Aug. 16, Palm City, Occidental, Aug. 16, Lockwood, July 24, Mann Co., Tehachapi, Lemon Cove, Mt. Diablo, Mariposa, Delta, June 28.

Notes: Range, along Pacific coast states, more frequently in California. In external appearance this form closely resembles *superbus, vermiculatus* and *angus.*

8. *Texananus* (*Texananus*) *angus* DeLong

Texananus angus DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 42.

Resembling *superbus* in form and coloration but with a slightly narrower crown and paler coloration; paired processes of ventral shaft of connective more slender and tapering to a sharp apex in lateral view; secondary excavation of female seventh sternum narrower and rounded.

Genitalia: Female seventh sternum two fifths as wide as long, lateral margins round, converging from base, posterior lateral angles rounded, continuous medially with a broadly excavated V-shaped posterior margin, its depth about three fifths sternum length and posterior half of margin slightly concave. Male in lateral view: Pygofer triangular in shape with a diagonal margin from ventral anterior corner to dorsal posterior acute-angled corner, greatest width about half length. Aedeagal base inclined dorsoposteriorly, concave on upper third, shortest length about third shortest aedeagal length; aedeagal shaft with basal depth of almost third aedeagal length, posteriorly directed a distance of about half aedeagal length, then curving abruptly dorsad and anterad as a sicklelike portion tapered to apex. Connective ventral shaft consisting of a pair of long stout tapering posterolaterally directed processes arising from a bulbous appearing base and terminating in a sharpened slightly turned down apical third. In dorsal view: Aedeagus much wider basally than along slender tapering apical portion. Connective U-shaped anteriorly; shaft processes posteriorly tapering and diverging; arm length about three fifths shaft median length.

Types: Holotype male, Uvalde, Texas; allotype, female, Cheyenne, Oklahoma, and male and female paratypes. Types deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Kansas) Pottawatomie County; (Texas) Sutton Co., July 16, Castroville, Rocksprings, Sheffield, Kendall Co., San Antonio, June 25, Seguin, Ozona, Elmendorf, Karnes, Alice, Romney, Concan, Palopinto Co., McAllen, Eastland Co., Menard Co., Aransas Co., August 6, Jim Wells Co., Del Rio, Uvalde; (New Mexico) Silver City.

Notes: Range, in Texas and parts of adjacent states northward. *P. superbus* being a meadow species of the southern states (DeLong 1926), suggests that the related form *P. angus* might well belong to this habitat.

9. *Texananus* (*Texananus*) *superbus* (Van Duzee)

Phlepsius superbus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 81.

Resembling *angus* in form and general coloration, but often slightly darker and with wider crown; paired processes of ventral shaft of connective suddenly reduced by a notch at upper border on apical third; secondary excavation of female seventh sternum broad and truncate at bottom.

Genitalia: Female seventh sternum two fifths as long as wide, lateral margins converging from base to rather narrowly rounded lateral angles, posterior margin broadly excavated by a wide concavity, about three fifths distance to base, anterior margin of excavation truncate and posterior two thirds of excavation margin slightly concave. Male in lateral view: Pygofer triangular, upper and lower margins sinuously converging posteriorly from anterior margin to a sharpened rounded apex, greatest anterior width about five fourteenths length. Aedeagal base dorsoposteriorly directed, length about one third aedeagal length, angularly concave, lower marginal two thirds curving anteriorly along the preatrium to articulation; aedeagal shaft with basal width about equal to base width posteriorly directed, tapering from proximal third as it curves dorsally and anteriorly to a point. Connective ventral shaft as pair of almost straight processes, tapering to their apices, apical two fifths contracted dorsally to a slender portion. In dorsal view: Aedeagus widest at articulation, tapering rapidly on proximal half to apex. Connective somewhat Y-shaped, arms closely parallel; shaft roundly expanded even wider than width at base or arms anterior to articulation divides near articulation into diverging, straight, tapering processes.

Types: N. C. type male designated by Dr. DeLong in Ohio Jour. Sci. (1938) and deposited in Iowa State College Entomological Collections. Two other specimens, one a male labeled Arizona, U. Lot 5, and the other without abdomen labeled Arizona; C. U. Lot 34, Cornell U. Lot 45 Sub. 435, are in series. Types studied.

Material studied: (Florida) Branford, July 16, Yankeetown, July 17, Sanford, Aug. 4, Loughman, Aug. 5; (Illinois) Dixon Springs, July 29; (Tennessee) Clarksville, July 4, 11, 14, Sept. 4, 24, Hixon, July 5, Magnolia, July 20; (Alabama) Elgin, July 6; (Missouri) Pineville, July 19; (Arkansas) Fouke, Dec. 21, Washington Co., June 30, Polk Co., Aug. 21, Fayetteville, Nov. 6; (Louisiana) Aloha, Dec. 23; (Oklahoma) Comanche Co., June 1; (Texas) Three Rivers, June 27, Progresso, July 1, Jackson Co., Aug. 9, Brewster Co., April

15, Mission, Dec. 26, Hidalgo Co., July 30, Cisco, June 19, Brownsville, June 29, San Antonio, May 4, Sanford, Aug. 25, Nov. 25.

Notes: Range, in southeastern and southern states across to Texas and Oklahoma and northward along Ohio River. In regard to type, Dr. DeLong designated the N. C. specimens and N. Carolina as the type locality in the Ohio Journal of Science 1938, and published drawings accordingly. A later designation by Dr. Oman 1946 specified the Arizona form as a lectotype. However, in correspondence with Dr. Oman in connection with this designation, Dr. Oman states that his subsequent designation 1946 of the Arizona form (which is *T. vermiculatus* DeLong) is invalidated by DeLong's previous designation.

10. *Texananus* (*Texananus*) *lathropi* (Osborn and Lathrop)

Phlepsius annulatus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 342, (homonym).
Phlepsius lathropi Baker, Philippine Journ. Sci., vol. 27, 1925, p. 159.

Resembling *extensus* in form and coloration but with more rosaceous tint; plates and valve much broader at base, ventral shaft of connective quite slender and slightly curving dorsad from base; secondary excavation of female seventh sternum broadly U-shaped and with excavation's posterior angles not produced beyond lateral angles of sternum.

Genitalia: Female seventh sternum about two sevenths as long as wide, lateral margins strongly narrowing from base, posterior lateral angles strongly produced between which the convex posterior margin is deeply excavated by a large U-shaped notch. Male in lateral view: Pygofer slightly narrowing posteriorly with posterior margin somewhat extended lobelike, greatest anterior depth about two thirds length. Aedeagal base rather upright, length slightly more than half aedeagal shortest length; preatrium from articulation apparently curving dorsad as a long "sickle-handle" to shaft; aedeagal shaft, with basal depth about fourth base length, departing from upper base, is directed posteriorly, dorsally and anteriorly in a tapering "sickle-like" portion to a slender apex. Connective ventral shaft portion long and slender, curving gently and slightly upward to a sharp point. In dorsal view: Aedeagus widest basally, narrowing rapidly on proximal portion; lateral apodemal beaks prominent. Connective Y-shaped with slender arms almost parallel; shaft at base of arms gradually narrowing to slender apical two-thirds.

Types: Destroyed by fire, according to Dr. F. H. Lathrop. Specimens, correctly identified, deposited in Ohio State University Entomological Collections. Compared with type material studied.

Material studied: (Idaho) Regina, Mar. 24; (California) Keen Camp, Trinita Sonoma Co., June 25, Jamesburg, Aug. 11, Giant Forest, July 28.

Notes: Range, in California and other western states.

11. *Texananus* (*Texananus*) *extensus* sp. nov.

Resembling *Texananus* (*Texananus*) *lathropi* in general body form; size, and style shape with outer margin longest, but scarcely with the rosaceous tint; the connective ventral shaft tapering and curved strongly dorsad on apical fourth; posterior corners of secondary excavation of female seventh sternum produced beyond lateral angles. Length, 5.5 mm.

Structure: Crown rather narrow, one-half longer at middle than next to eye, slightly convex in lateral view, apex subconical in dorsal view. Clypeus rather uniformly convex, its width at base slightly more than three fifths length. Clypellus rectangular, slightly constricted along middle. Pronotum about three sevenths as long as wide, evenly rounded anteriorly and slightly concave on posterior marginal three fifths, rugose on posterior border. Elytra evenly and broadly rounded on costal margin and on apices.

Color: Crown, pronotum and scutellum yellowish to stramineous with irregular angular short streaks of brown on crown with a pair of larger spots at apex, and blotches of brown on pronotum. Clypeus covered with lateral arcs, many of them fragmented on upper half, a dark area spotted with yellow below crown apex. Clypellus with pair of dark areas at its base. Elytra milky white with rather sparsely located vermiculate or irrorate markings, a distinctly trilolate commissural line. Costal spots small and narrow, lying close to margin.

Genitalia: Female seventh sternum one half as long as wide, lateral margins rather strongly and roundly converging from base, posterior lateral angles rather acutely produced, posterior margin with a deep V-shaped excavation on middle with its margin darkened and posterior angles produced beyond lateral angles. Male in lateral view: Pygofer somewhat rectangular with dorsal and ventral margins converging posteriorly to a rounded apex, its greatest width about three fourths length. Aedeagal base dorsoposteriorly directed, its length five eighths aedeagal length, ventral marginal third curving anteriorly along preatrium to articulation, preatrium extended upward to shaft as a "sickle handle"; aedeagal shaft with basal width of fifth base length is posteriorly directed from dorsal base portion, then curves dorsoanteriorly and tapering on slender,

rather straight apical half to apex. Connective ventral shaft broad at articulation, tapering to apex, apical fourth curved strongly dorsad, ventral shaft length about equalling aedeagal length. In dorsal view: Aedeagus roundly broadest at articulation, moderately constricted anterior to blunt short apodemes, shaft slender, tapering to apex. Connective Y-shaped, with arms expanded laterally at their middle; shaft broad, about half as wide as at articulation, tapering to sharpened apex beyond articulation, shaft length about two fifths longer than arm length.

Types: Holotype male, allotype female, three male and two female paratypes, Claremont, California, July 29, 1935, R. H. Beamer; one male and one female paratypes, Elsinor, California, Aug. 3, 1935, R. H. Beamer; one male paratype, Pasadena, California, July 12, 1931, E. D. Ball. Holotype, allotype and paratypes deposited in Snow Entomological Collections, University of Kansas; one paratype deposited in the U. S. National Museum.

Material studied: Only type material.

Notes: Range, in California. Shape of style is distinct but similar to that of *T. lathropi* (Baker) but unlike that of other species of the genus *Texananus*.

12. *Texananus* (*Texananus*) *mexicanus* (Ball)

Phlepsius mexicanus Ball, Ann. Ent. Soc. Amer., vol. 11, 1918, p. 385.

Resembling *spatulatus* in body form and coloration but more robust crown rounded at apex and color dark brown; a median connective ventral shaft between short lateral paired prongs; female seventh sternum narrowing from base to a narrow median lobe, with lateral rounded membranes.

Genitalia: Female seventh sternum three fifths as long as wide, lateral margins converging extremely from base to a posteriorly directed median lobe, lateral irregular membranes projecting from under lateral margins. Male in lateral view: Pygofer almost quadrangular, greatest width nine tenths length. Aedeagal base inclined dorsoposteriorly, length about half aedeagal length, preatrium extremely long and sinuous to articulation; aedeagal shaft with basal depth of half base length, posteriorly directed and tapering as it curves sharply dorsad and back anteriorly to an upturned apex. Connective ventral shaft very broad at articulation, posteriorly directed, tapering as it curves moderately dorsad to sharp apex; pair of basal sharp spinelike processes about half ventral shaft length. In dorsal view: Aedeagus expanded basally into anterolateral projections, shaft slender. Connective Y-shaped,

arm converging apically but expanded laterally at their base; shaft at articulation with sharpened lateral horns, shaft length three times arm length; basal spines parallel, appressed to ventral shaft.

Types: Lectotype male, Orixaba, Mexico, H. S. and F. D. G., Dec. 1887, here designated; six cotypes, Chilpancingo, Mexico; one female from Vienna Museum labeled mexicana det. Sign. Types in collection of E. D. Ball deposited in U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Arizona) Sunnyside Canyon of Huachuca Mts., July 9, Mustang Mts., June 20.

Notes: Range, in Mexico and in adjacent state of Arizona. The pair of basal spines at base of connective ventral shaft, the small aedeagus dorsally distant from connective as well as the peculiar female seventh sternum make this a characteristic species.

13. *Texananus* (*Texananus*) *latipex* DeLong

Texananus latipex DeLong, Bull. Brooklyn Ent. Soc., vol. 38, 1943, p. 124.

Resembling *ovatus* in form and coloration but narrower, smaller, and irrorations rather indistinct; aedeagal apex bifid in lateral view and connective ventral shaft tapering and gently curving dorsad to a sharp apex.

Genitalia: Female seventh sternum one third as long as wide, lateral margins strongly converging on their posterior two thirds, posterior lateral angles acutely produced, wide posterior margin truncate with a median small U-shaped notch. Male in lateral view: Pygofer somewhat trangular, upper and lower margins roundly expanded, posterior angle bluntly rounded and slightly turned up, greatest depth two thirds length. Aedeagal base, inclined dorsoposteriorly, lower marginal third curving anteriorly along the preatrium to articulation; aedeagal shaft with basal depth of about fourth base length, departing posteriorly from base middle, curving dorsad on its proximal two fifths and terminating in a deeply cleft anteriorly directed apex with upper tapering portion longer. Connective ventral shaft posteriorly directed, curving upward gradually and tapering to a sharp pointed apex. In dorsal view: Aedeagus wider basally, narrowing to tapering shaft proper. Connective Y-shaped with arms stout basally; shaft broad at base of arms, rather uniformly narrowing to apex, its length about three times arm length.

Types: Holotype male, Ashford, Arizona, July 6, 1937, allotype female, same, and paratype males and females, same. Paratypes:

Wickenburg, Arizona; Glenns Ferry, Idaho; Payette, Idaho; Corvallis, Oregon; Shoshone Basin, Idaho; Dixie National Forest, Nevada; Chiricahua Mts., Arizona; Faust, Utah; American Falls, Idaho; Tuttle, Idaho; Bruneau, Idaho. The Arizona specimens collected by D. J. and J. N. Knull. Types deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Montana) Yellowstone County, July 16; (Wyoming) Goshen Co., June 23, Wheatland, July 14, Lusk, July 14; (Colorado) Lyons, July 9, Buckhorn Creek, July 11, Calhan, Aug. 19, Las Animas, Aug. 20, Fort Collins, Aug. 31, Sept. 26, Colorado Springs; (New Mexico) Portales, July 16, Socorro Co., Aug. 18, Yavapai Co., Cuervo, Tajique, June 25, Taos Taos Co., Aug. 20, Silver City, July 22, White's City, July 13, Hillsboro, Colfax Co., Aug. 21, Las Cruces, June 8, Cloudcroft, June 28, Belen, Aug. 19, Roseville, June 26, Las Vegas, July 18, Springer; (Idaho) Bliss, July 7; (Utah) Zion Nat. Park, Aug. 13, Thatcher, July 26, Willard, Campus, Trenton, June 11, Josepa, May 26, Kanab, Aug. 9, Pintura, Aug. 11, Moab, Snowville, July 6, Honeyville, Jensen, Ogden, Logan, July 10, Orderville; (Nevada) Humboldt, June 26; (Arizona) Flagstaff, July 8, Chiricahua Mts. June 9, Aug. 7, Granite Dell, Kaibab Forest, Grand Canyon, Ruby, Miami, July 22, Mustang Mt., June 12, St. Johns, July 26, Mescal, Jerome, Santa Rita, Gila Co., Salerno Canyon, Wilcox, Globe, Ruby, July 27; (Washington) Toppenish, July 8, Satus Pass, July 9; (Oregon) Criterion, July 2, Yoncalla, July 12, Arlington, July 15, Biggs, July 16, Boardman, July 15, Dixie; (California) Carlsbad, Aug. 6, Anza, Aug. 6, Occidental, Aug. 16, San Diego, Ontario, Beaumont, July 26, Monterey, July 22, Elsinor, Dulzura, Lemon Cove, Alpine, Laguna Beach, July 25, San Jacinto Mts., July 21.

Notes: Range, throughout the western states. Considerable variations in coloration and size exist in this species. Large collections varying in size suggest large populations undergoing evolutionary changes.

14. *Texananus* (*Texananus*) *areolatus* (Baker)

Phlepsius areolatus Baker, Canadian Ent., vol. 30, 1898, p. 30.

Resembling *fumosus* in body form and general markings but body slightly larger and with light brown irrorations and vermiculate lines; connective ventral shaft in lateral view only slightly expanded along apical half and its apex reduced to a rounded point; female seventh sternum concavely converging on its posterior half and posterior margin broadly and slightly concave with small median notch.

Genitalia: Female seventh sternum about three sevenths as long as wide, lateral margins converging concavely on their posterior half, posterior lateral angles not produced, posterior marginal middle slightly concave with a distinct median V-shaped notch. Male in lateral view: Pygofer plainly triangular, posterior angle widely rounding, greatest depth about five ninths length. Aedeagal base nearly upright, length about equals aedeagal length, its lower marginal half curving anteriorly along preatrium to articulation; aedeagal shaft short, continuous dorsoposteriorly in line with preatrial lower margin and turning dorsad on apical third to blunt apex. Connective ventral shaft with apex of shaft avicephaliform. In dorsal view: Aedeagus widest on basal half, narrowing to rounded apex on apical half. Connective Y-shaped, arms closely parallel; shaft slender but roundly widened anteriorly to aedeagal attachment, its length about half longer than arm length.

Types: Holotype, Onaga, Kansas, F. F. Crevecoeur, in collection of E. D. Ball deposited in the U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (Mississippi) Okelona, June 28; (Nebraska) Indianola, July 21; (Kansas) Osborne Co., Aug. 16, Rawlins Co., Pottawatomie Co., Phillips Co., Sherman Co., Lawrence, Oct. 10, Ottawa, Sept. 24, Liberal, Aug. 16, Kiowa Co., July, Reno Co., Aug. 13, Medora, July 2, Garnett, July 7, Coffey Co., June 19; (Mississippi) Oklona; (Texas) Catarina, July 6, Dallas, Dec. 5, Potter Co., July 7.

Notes: Range, from Nebraska to Texas. A distinct species with dorsal areolate coloration and depressed crown.

15. *Texananus* (*Texananus*) *extremus* (Ball)

Phlepsius extremus Ball, Canadian Ent., vol. 33, 1901, p. 10.

Resembling *areolatus* in body form and coloration but much smaller, crown wider and its margin thicker, coloration not areolate but with irrorations irregular; connective ventral shaft in lateral view tapering from its base and slightly turned dorsad to a pointed apex; female seventh sternum with lateral margins about parallel, only converging on their posterior third, posterior margin broadly and roundly excavated with indications of pair of median lobes at bottom of excavation.

Genitalia: Female seventh sternum length about one third as long as wide, lateral margins converging strongly on posterior half, posterior lateral angles produced, between which the posterior margin is broadly excavated with a pair of indicated lobes separated

by a shallow notch at the bottom. Male in lateral view: Pygofer rectangular, posterior third of upper margin sloping ventrally to a narrowed posterior margin, greatest pygofer width about three fourths length. Aedeagal base inclined dorsoposteriorly, its length about half aedeagal length, preatrium short; aedeagal shaft short and stout with a basal depth of about three fourths base length, posteriorly directed and tapering as it curves dorsally to a truncate apex. Connective ventral shaft slightly longer than aedeagus, tapering to a sharpened apex slightly turned dorsad. In dorsal view: Aedeagus ovate from articulation to apex. Connective Y-shaped but arms linear, paralleling each other to their converging apices; shaft tapering to apex, its length half longer than arm length.

Types: Lectotype female, Rifle, Colorado, July 28, 1900, here designated; two male and one female syntypes from Rifle and Durango, Colorado. Types in collection of E. D. Ball deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Utah) Provo, St. George, July 29, Orderville, June 25; (Arizona) Lupton, Aug. 28; (Oregon) Medford, Aug. 14; (California) Beaumont, July 26, Aug. 1, Chilcoot, July 22, Ontario, June 12, Riverside, June 13, Pine Valley, July 6, Cajon Pass, Aug. 6, Campo, Aug. 10, Escondido, July 15, Mt. Diablo, Aug. 21, Claremont, July 29, Boulevard, July 19, Quatay, July 19, LaJolla, July 13, Orange County, July 14, Mint Canyon, July 6.

Notes: Range in western states. Its flat crown and somewhat linear connective makes this form interestingly distinct.

16. *Texananus* (*Texananus*) *fumosus* sp. nov.

Resembling *Texananus* (*Texananus*) *areolatus* (Ball) in areolate appearance and body contour but with brownish black vermiculate lines in cells of wing, and connective ventral shaft only expanded slightly on apical half in lateral view. Length, male, 6 mm., female, 7 mm.

Structure: Crown rather wide, one third longer at middle than next to eye, moderately depressed behind anterior margin, angulate with front. Clypeus wedge-shaped, the basal width slightly more than two thirds as long as wide. Clypellus moderately constricted through middle. Pronotum with anterior margin rounded, slightly concave on posterior margin, rugose on posterior half of disc. Elytra broadly rounding in dorsal view, claval veins irregularly tortuous, secondary lines of coloration across cells of corium.

Color: Crown heavily marked with dark brown areas with ivory spot on middle of vertex connected with spot near middle of crown, two ivory spots on lateral margins of crown, ivory on posterior border. Clypeus uniformly marked with tortuous irregular broken arcs, separated into lateral arcs on ventral half. Pronotum with rounded blotches of dark brown on anterior half, irregularly marked posteriorly. Scutellum with paired ivory markings lateral to brown areas. Elytra with ivory to milky background with almost black vermiculate lines forming secondary veins or darker border within cell boundaries.

Genitalia: Female seventh sternum about one third as long as wide, lateral margins converging from base, posterior lateral angles not produced, posterior margin only slightly concave with a small V-shaped median notch. Male valve triangular, apex rounded, its length about twice its width. Plates roundly broad on basal third, tapering laterally to a rounded apex with membranous extensions beyond apex. Male in lateral view: Pygofer somewhat triangular, posterior half of dorsal margin sloping ventrally, then posteriorly, lower posterior corner rounded, greatest width slightly more than two thirds length. Aedeagal base dorsoposteriorly directed, its length about half aedeagal length, lower marginal half curving slightly anterad along the preatrium to articulation; aedeagal shaft stout and short with basal width of half base length, posteriorly directed on proximal half, tapering slightly as it curves dorsad to rounded apex. Connective ventral shaft posteriorly directed and slightly swollen on apical half to sharpened apex. In dorsal view: Aedeagus roundly widened at articulation and at apodemal base, tapering to blunt apex. Connective with linear paralleling arms; shaft slender, widening at articulation then tapering to a point.

Types: Holotype male, allotype female, and pair of paratypes, Eureka, Kansas, Sept. 7, 1949, C. D. Michener and R. H. Beamer. Other paratypes: five males and two females, Texas City, Texas, Feb. 2, 1932, L. D. Tuthill; one male, Lawrence, Kansas, Oct. 10, 1936, D. R. Lindsay; one male, Meade Co., Kansas, Sept. 13, 1944, R. H. Beamer; one female, Galena, Kansas, Oct., 1912, five males and three females, Ottawa, Kansas, Sept. 24, 1925, E. P. Breakey; one female, Dallas, Texas, Dec. 5, 1945, R. H. Beamer; one male and one female, Waco, Texas, Oct. 15, 1939, P. A. Glick; one female, Baldwin, Kansas, May, J. C. Bridwell; one female, Grimes Co., Texas, Oct. 4, 1931, R. K. Fletcher; one male, Kansas. Holotype,

allotype, and paratypes deposited in Snow Entomological Collections University of Kansas; paratypes in U. S. National Museum.

Material studied: Only type material.

Notes: Range, Kansas and southward.

17. *Texananus* (*Texananus*) *dolus* DeLong

Texananus dolus DeLong, Pan-Pacif. Ent., vol. 14, 1938, p. 186.

Resembling *decorus* in form and coloration but varying to larger size, with broader crown; connective ventral shaft in lateral view broad from its base, slightly wider apically and apex contracted from above to a sharpened point in line with lower margin; female seventh sternum with large secondary median U-shaped notch.

Genitalia: Female seventh sternum about half as long as wide, lateral margins converging from base to a wide convexly rounding posterior margin, with a wide V-shaped median excavation narrowed to a U-shaped notch anteriorly almost reaching base of sternum. Male in dorsal view: Pygofer triangular, upper and lower margins converging posteriorly to a bluntly rounded point, greatest width about seven tenths length. Aedeagal base dorsoposteriorly inclined, length about half aedeagal length, its lower half curving anteriorly along the preatrium to articulation; the shallow preatrium curved obliquely upward as a "sickle handle" of the heavier sickle-like shaft; aedeagal shaft with basal width of almost half base length, departs upper base posteriorly, tapering as it curves dorsally and anteriorly in a slender straightened apical third. Connective ventral shaft with sharp apex formed by dorsal margin sloping to ventral margin. In dorsal view: Aedeagus widest at base narrowing to apex, posterolateral apodemal horns bluntly stout. Connective Y-shaped with sinuously parallel arms; shaft moderately wide, slight narrowing to tapered apex.

Types: Holotype male and allotype female, Logan Canyon, Utah, July 24, 1930, D. M. DeLong, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (North Dakota) Linton, July 23, Leonard, July 25; (South Dakota) Red Field, July 20; (Manitoba) Red Deer R., Aug. 3, Keld; (Wisconsin) Brule, Aug. 16; (Montana) Bozeman, Aug. 13.

Notes: Range, in western states and northern states of Great Plains. The aedeagal structures as above described are slightly different in longer plate and deeper aedeagal ventral process than in *T. decorus,* however intermediate variations seem to appear be-

tween the two extreme forms. It is possible that *T. dolus* should be considered as a variation of *decorus*.

18. *Texananus* (*Texananus*) *sonorus* Ball

Texananus sonorus Ball, Bull. Brooklyn Ent. Soc., vol. 31, 1936, p. 19.

Resembling *decorus* in body form and color markings but with broad crown and lighter in color; connective ventral shaft in lateral view tapering from broad base to slightly upturned sharp apex; female seventh sternum with a broad quadrangular notch posteriorly.

Genitalia: Female seventh sternum slightly more than half as long as wide, lateral margins roundly converging from base to posterior lateral angles, their inner margins convexly rounding and continuous with a deep U-shaped excavation, about two thirds distance to base. Male in lateral view: Aedeagal base dorsoposteriorly directed, its length about three eighths aedeagal length, slightly concave with lower marginal two thirds curving anteriorly along the preatrium to articulation, preatrium with a "sickle-handle" shape; aedeagal shaft sickle-shaped with basal width of one half base length, posteriorly directed on proximal half, then curving dorsally and tapering to a slightly expanded apex. Connective ventral shaft tapering to apex, apical fifth very slightly curved ventrad then posteriorly to a sharpened point.

Types: Holotype female and allotype male, Atascosa Mt., Arizona, Aug. 15, 1935, E. D. Ball, in collection of E. D. Ball, deposited in the U. S. National Museum. Sketch outlines of style (dorsoventral view) and aedeagus and connective (lateral view) available for study through courtesy of Dr. P. W. Oman.

Material studied: Only sketches drawn of types.

Notes: Range, southern Arizona. This form is a relative of the *decorus* group of species.

19. *Texananus* (*Texananus*) *decorus* Osborn and Ball

Phlepsius decorus Osborn and Ball, Proc. Iowa Acad. Sci., vol. 5, 1897, p. 230.

Resembling *dolus* in body form and coloration but slightly smaller and with narrower crown; connective ventral shaft in lateral view moderately broad, slightly tapering on apical half, contracted from above subapically to a sharpened apex in line with lower margin; female seventh sternum with lateral margins roundly and strongly converging to a large median V-shaped excavation which is narrowed at its base into a secondary notch.

Genitalia: Female seventh sternum about two sevenths as long

as wide, lateral margins nearly parallel on anterior third, then converging extremely to slightly truncate posterior lateral angles which border a deep V-shaped excavation, its apex narrowed somewhat, and its depth about five-eights length of sternum. Male in lateral view: Pygofer somewhat rectangular, narrowing posteriorly, with the lower posterior corner rounding upward to a bluntly acute point, upper margin angularly rounding upward, its greatest width about two thirds length. Aedeagal base dorsoposteriorly inclined, its length about half aedeagal length, preatrium from articulation expanding to shaft as a "sickle-handle"; aedeagal shaft "sickle-shaped" with basal width of third base length, posteriorly directed from upper base portion, tapering and curving dorsally and anteriorly in a uniform curvature to its slightly bifid apex. Connective ventral shaft extending posteriorly as a stout slightly tapering blade terminating in a slight subapical curve ventrally, then curving posteriorly to apex. In dorsal view: Aedeagus wider basally than tapering apical shaft portion, lateral apodemes slender. Connective Y-shaped with sinuous arms; shaft broad, narrowing posteriorly from aedeagal articulation to its sharpened apex.

Types: Lectotype male, Lincoln, Nebraska, October 2, 1892, Bruner, designated by P. W. Oman (1946) in the Iowa State College Entomological Collections. One female syntype in same collections.

Material studied: (Maine) Bar Harbor, Sept. 20; (Massachusetts) Mt. Tom, Oct. 3; (Connecticut) New Haven; (Maryland) Annapolis, Sept. 30; (District of Columbia) Washington, Sept. 13; (Virginia) Arlington, July 22; (Florida) Sanford, July 31; (Missouri) Hollister, July 22; (Nebraska) Bartley, July 15; (Kansas) Ottawa, Oct. 1, Garnett, Oct. 8, Miami Co., Doniphan Co., Linn Co., Galena, October, Leavenworth, June 24, Onaga, July 7.

Notes: Range, east of the Rocky Mts. A meadow species of the northern states (DeLong 1926).

20. *Texananus* (*Texananus*) *deversus* DeLong

Texananus deversus DeLong, Ohio Jour. Sci., vol. 49, 1949, p. 182.

Resembling *ovatus* in form and coloration externally but larger and resembling *decorus* in male genital parts; connective ventral shaft, in lateral view, slender and tapering to apical third which bends ventrally then caudally to sharpened apex; female seventh sternum with lateral margins strongly converging to posterior lateral angles, posterior margin with broad rounded primary excavation and narrow secondary median excavation nearly to its base.

Genitalia: Female seventh sternum about half as long as wide, lateral margins strongly converging from base, posterior lateral angles roundingly produced on either side of a concave posterior middle, excavated almost to base by a deep V-shaped notch. Male in lateral view: Pygofer rectangular, lower posterior corner rounding, greatest width about seven ninths length. Aedeagal base almost upright, length about half aedeagal shortest length, concave on lower half with lower marginal third curving anteriorly to articulation along the preatrium; aedeagal shaft sicklelike, with basal width of almost one fourth base length, departing near middle of base, is posteriorly directed proximally, tapering as it uniformly curves upward and anteriorly to a slender apex. Connective shaft posterior to aedeagal articulation slender, slightly tapering to apical third which curves strongly ventrally, then posteriorly to sharp apex. In dorsal view: Aedeagus widest at base, tapering gradually to apex; apodemes inconspicuous in this view. Connective Y-shaped, swollen near aedeagal articulation, then tapering to apex; shaft about three fourths longer than arm length.

Types: Holotype male, allotype female, and female paratypes, Brownsville, Texas, May 25, 1939, D. J. and J. N. Knull, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: Only type material.

Notes: Range, Brownsville, Texas.

21. *Texananus* (*Texananus*) *pergradus* DeLong

Texananus pergradus DeLong, Pan-Pacif. Ent., vol. 14, 1938, p. 185.

Resembling *latipex* in form and coloration but margin of vertex more bluntly rounded and genital parts distinct; connective ventral shaft in lateral view extremely slender and moderately short, curving gently upward from base; female seventh sternum about one third as long as wide, with posterior margin roundly concave, secondary median excavation semicircular with small median notch at its bottom.

Genitalia: Female seventh sternum slightly more than one third as long as wide, lateral margins converging from base to rounding posterior lateral angles, posterior margin roundly concave, with a secondary median semicircular excavation notched anteriorly with a small notch, the entire excavation depth about half sternum length. Male in lateral view: Pygofer triangular, dorsal and ventral margins converging moderately from anterior border, more so on posterior third, forming a right angled rounded apex. Aedeagal base dorsoposteriorly inclined, length about half aedeagal length, slightly con-

cave with lower marginal half curved anteriorly along a narrow preatrium to articulation; aedeagal shaft with basal width of one third base length, departs upper base posteriorly, slightly tapering as it curves uniformly dorsad and anteriorly to apex. Connective ventral shaft posteriorly directed, slender, hairlike, curving slightly upward. In dorsal view: Aedeagus broad at articulation, narrowing posteriorly to apex, excepting long lateral apodemes above atrial openings. Connective Y-shaped, arms swollen laterally on apical half; shaft expanding at articulation then narrowly reduced as a slender hairlike shaft.

Types: Holotype male, allotype female, and male and female paratypes, Jemez Springs, New Mexico, June and September, 1919, and paratypes from Uvalde, Texas (Knull), and Monterey, Mexico, deposited in collection of Dr. D. M. DeLong. Paratypes, male and female, Modena, Utah, Desert, Utah, and Cedar City, Utah, deposited in collection of Herbert Osborn. Types studied.

Material studied: (Texas) Three Rivers, June 27, San Antonio, McAllen, Dec. 30, Concan, July 6; (New Mexico) Hartford, July 17, Springer, July 17, Belen, July 17, Portales, July 16, Blue Springs, July 10; (Arizona) Tubac, Aug. 21, Sabino Canyon, July 14, Mescal, July 28, Santa Rita Mts., Aug. 1, Granite Dell, July 11, Yavapai, Aug. 9; (California) Woodlake, May.

Notes: Range in southwestern states.

22. *Texananus* (*Texananus*) *ovatus* (Van Duzee)

Phlepsius ovatus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 79.

Resembling *ovatus* subsp. *distinctus* in body form and coloration but color markings pale and trilobed commissural line not so distinct; male pygofer more reduced in width on its posterior half in lateral view; female seventh sternum usually lighter in coloration and with the median notch usually deeper toward base of sternum.

Genitalia: Female seventh sternum about one fourth as long as wide, lateral margins strongly converging from base; posterior lateral angles produced, posterior margin truncate with wide Y-shaped notch, narrowing anteriorly and almost reaching base. Male in lateral view: Pygofer somewhat rectangular, narrowing posteriorly to rounded posterior margin, greatest width five sevenths length. Aedeagal base inclined dorsoposteriorly, its length slightly more than half aedeagal length, lower marginal half curving anteriorly along the preatrium to articulation; aedeagal shaft with width of third base length posteriorly directed, curving dorsad and tapering as it turns sharply anteriorly to slender apex. Connective

ventral shaft very slightly tapering to a pointed apex with a pair of dorsal subapical notches. In dorsal view: Aedeagus squarely widened at base, tapering along shaft to apex; lateral apodemes long and slender. Connective Y-shaped with arms expanding outward on apical half; slender shaft widened at articulation, apex with pair subapical teeth, its length fourth longer than arm length.

Types: Lectotype (female?) Texas, designated by P. W. Oman (1946) in Iowa State College Entomological Collections. One specimen (abdomen missing) labeled "Tex., Type." in same collections. Type studied.

Material studied: (Kansas) Liberal, Aug. 16, Meade, Karnes Co., July 23; (Arkansas) Polk County, July 21; (Louisiana) Caddo Co., Bossier Park; (Oklahoma) Wichita National Forest, June 28, Muse, Sayre; (Texas) Davis Mts., Gillespie Co., Val Verde Co., Denison, Concan, Sarita, Dec. 25, Tyler, Karnes Co., Kendall Co., Jim Wells Co., San Antonio, Jackson Co., Aug. 9, San Juan, George West, Aransas Co., Aug. 6, Bee Co., Brooks Co., Palopinto Co., San Saba Camp, July 1, Seymour, Peeler, June 22, Harris Co., Victoria Co., Hidalgo Co., July 28, Elmendorf, July 3, Three Rivers, June 27, Romney, Seymour.

Notes: Range, in south central states with large populations in Texas. It is close in structure to a subspecies, *distinctus*, a darker form.

23. *Texananus* (*Texananus*) *ovatus* subsp. *distinctus* (Lathrop)

Phlepsius distinctus Lathrop, Ohio Jour. Sci., vol. 17, 1917, p. 129.

Resembling *ovatus* in body form and coloration, but color of irrorations much darker and trilobed commissural line more distinct; male pygofer roundly broad in lateral view toward its posterior margin; female seventh sternum usually dark in coloration. and bottom of median notch not close to base of sternum.

Genitalia: Female seventh sternum slightly more than fourth as long as wide, lateral margins converging strongly from base, posterior lateral angles prominently produced, middle posterior margin truncate with a wide V-shaped notch narrowed anteriorly near sternum base. Male in lateral view: Pygofers nearly rectangular, roundly reduced from above and below to a rather truncate posterior margin, greatest width about three fourths length. Aedeagal base nearly upright, length almost half aedeagal length, its lower marginal third curving anteriorly along the preatrium to articulation; preatrium curved upward forming a "sickle-handle" below the sicklelike shaft; aedeagal shaft with basal width of one third base

length, departing upper base portion obliquely, posteriorly curving dorsally and anteriorly as it tapers to a slender apical third. Connective shaft posterior to aedeagal articulation slender, posteriorly directed on proximal third then curving slightly upward to apex, reduced to lower sharpened half with a pair of dorsal teeth subapically placed. Male in dorsal view: Aedeagus widest basally, tapering to bifid apex; anterolateral apodemal horns slender. Connective Y-shaped with arms round, separating on apical half, then converging; shaft slender, apex abruptly pointed, a pair of teeth subapically placed, its length one fourth longer than arm length.

Types: Destroyed by fire according to Dr. F. H. Lathrop. Specimens in Herbert Osborn Collection, deposited at Ohio State University at time of description, were compared with type according to Dr. F. H. Lathrop. Compared with type specimens studied.

Material studied: (Georgia) Adel, Aug. 11, Okefenokee Swamp, July 25; (Florida) Suwanee Springs, Aug. 2, Waldo, Aug. 18, Wakulla, July 10, Branford, July 16, LaBelle, Liberty County.

Notes: Range, southeastern states. Habitat in grasses of open pine woods where growth is luxuriant and of herbaceous forms (DeLong 1926).

24. *Texananus* (*Texananus*) *sextus* sp. nov.

Resembling *Texananus* (*Texananus*) *validus* n. sp. in form, size, and coloration, but with more vermiculate dark markings, and a rosaceous tint on elytra, female seventh sternum with brownish coloration, male connective ventral shaft abruptly curved posteriorly on its apical sixth. Length 6 mm.

Structure: Crown one fourth longer at middle than next to eye, nearly flat, slightly depressed anteriorly and posteriorly, angulate with front. Clypeus two sevenths longer than its basal width, wedged-shaped and rather evenly convex. Clypellus gradually widening to truncate apex. Pronotum rounded anteriorly, broadly and slightly concave posteriorly, its length almost half its width, rugose on posterior two thirds. Elytra in dorsal view broad, ovate in appearance, apices rounded.

Color: Dorsum of body uniformly marked with brown vermiculate markings. Crown with dense brown markings in form of band between eyes, yellowish anteriorly with pair of lateral spots. Clypeus embrowned with lateral yellowish broken arcs on ventral two thirds. Clypellus with two brown spots at base and somewhat rectangular area on its middle. Elytra evenly marked with irrorate and vermiculate mark, slightly tinted with rosaceous, costal border with several small brown spots.

Genitalia: Female seventh sternum about one fourth as long as wide, lateral margins strongly converging to rather truncate posterior margin, a semicircular excavation on posterior middle about half way to base, a median notch at excavation bottom. Male valve triangular, lateral angles roundly acute, apex obtuse. Plates widest on basal half, roundly narrowing to an acute apex at inner margin. Male in lateral view: Pygofer nearly rectangular, posterior margin convexly pointed, greatest width about five sevenths length. Aedeagal base inclined dorsoposteriorly, its length three fifths aedeagal length, concave below with its lower marginal third curving anteriorly along the preatrium to articulation, preatrium curving upward at right angles to form a "sickle handle" for shaft; aedeagal shaft "sickle-shaped" with a basal width of fourth base length, posteriorly directed and tapering on proximal half, then curved dorsally and anteriorly to slender apex. Connective ventral shaft broad at articulation, tapering as it curves very slightly upward to the apical sixth which curves posteriorly to a sharp point. In dorsal view: Aedeagus widest at articulation, narrowing slightly along base to short lateral apodemes; shaft slender, tapering to apex. Connective Y-shaped with arms sinuously parallel; shaft stout, broad at base of arms, tapering posteriorly to apex, its length about three times arm length.

Types: Holotype male, allotype female, three male and five female paratypes, Atascosa Mt., Aug. 16, 1937, E. D. Ball. Holotype, allotype and paratypes deposited in the U. S. National Museum; paratypes in Snow Entomological Collections, University of Kansas.

Material studied: Only type material.

Notes: Range, known for only above locality.

25. *Texananus* (*Texananus*) *gladius* DeLong

Texananus gladius DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 41.

Resembling *ovatus* in body form and general coloration but elytra with heavy distinct darkened irrorations and commissural lobes rather pale and distinctly set off; connective ventral shaft in lateral view moderately stout and uniform in size to apical third, which curves upward, tapering to a sharpened posteriorly directed apex; female seventh sternum with posterior half of lateral margins strongly converging, posterior margin almost truncate with a large round median excavation.

Genitalia: Female seventh sternum one third as long as wide, lateral margins about parallel on basal half but strongly converging posteriorly, posterior margin truncate with a rounded large

median excavation at middle. Male in lateral view: Pygofer scarcely rectangular, upper posterior margin sloping downward on posterior half to a rounded upper corner, lower posterior corner rounded, its greatest width about five sevenths length. Aedeagal base somewhat inclined dorsoposteriorly, length about half aedeagal length, deeply concave with lower marginal two fifths curving anteriorly along the preatrium to articulation, preatrium curving upward as a "sickle handle" to shaft; aedeagal shaft with basal width of one third base shortest length, posteriorly directed from upper base, then curved upward, tapering as it strongly curves back anteriorly to apex. Connective ventral shaft stout, posteriorly directed with apical third turned upward, tapering to a sharp apex which curves sharply posteriorly. In dorsal view: Aedeagus widest at base, gradually tapering to apex; lateral apodemal processes long and tapering. Connective Y-shaped, but arms narrowly paralleling each other from broad base; shaft broad, widest at articulation, slightly narrowing toward a slightly sagitate apex.

Types: Holotype male Huachuca Mts., Arizona, August 18, 1936, allotype female, Gillespie Co., Texas, June 14, 1934, and male and female paratypes, Gillespie Co., same date, J. N. Knull, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Texas) Brewster, April 15, Alpine; (Arizona) Huachuca Mts., Aug. 22, Quinlan Mts., Sabino Canyon, Wilmen Valley, Chiricahua Mts., July 4, Arivaca, Baboquivari Mts:, July 19.

Notes: Range, in Arizona across to Texas.

26. *Texananus* (*Texananus*) *denticulus* (Osborn and Lathrop)

Phlepsius denticulus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 345.

Resembling *ovatus* in general body form but smaller and margin of crown conical, coloration pale and irrorations uniform; connective ventral shaft in lateral view moderately stout and short, very slightly swollen subapically and sharpened apex slightly turned dorsad; female seventh sternum distinct with two pairs of prominent medium teeth produced about equally from posterior margin.

Genitalia: Female seventh sternum about half as long as wide, lateral margins converging rather strongly from base, posterior lateral angles strongly produced, posterior margin produced mesally as pair of slender lobes separated by a deep notch, lateral to which are a pair of slightly longer teeth-like lobes directed inward. Male in lateral view: Pygofer somewhat rectangular, upper margin roundly raised, lower posterior corner rounded dorsoposteriorly to

an upper projected blunt corner, its greatest width about five eighths length. Aedeagal base, nearly upright, its length about two fifths aedeagal length, concave with lower marginal half curving anteriorly along the preatrium to articulation; aedeagal shaft sicklelike, with basal width about one fourth base length, posteriorly directed on proximal third, then tapering as it curves dorsally and posteriorly to a slender apex. Connective shaft posterior to aedeagal articulation rather short and straight, "short-sword" shaped, very slightly curved upward along shaft to apex. In dorsal view: Aedeagus much wider basally, reduced suddenly to a slender tapering shaft, lateral apodemal processes short and blunt. Connective Y-shaped, with short arms converging apically, then apex turned outward; shaft stout, sinuous sided to aedeagus then gradually tapering to apex, shaft length two and one-half times arm length.

Types: Holotype and ten paratypes, Los Banos, California, May 23, 1918, E. P. Van Duzee, deposited in California Academy of Science Museum. Specimens compared with type by Dr. E. S. Ross.

Material studied: (California) Bakersfield, July 24, Antioch, July 20, Cayuma Ranch.

Notes: Range, in California.

27. *Texananus* (*Texananus*) *graphicus* (Ball)

Phlepsius graphicus Ball, Canadian Ent., vol. 32, 1901, p. 201.

Resembling *cumulatus* in body form and coloration but slightly larger and irrorations more sparse; connective ventral shaft in lateral view gradually curving upward and considerably broadened on apical half, then quickly tapering into an upturned sharp apex; female seventh sternum with a wide deep parallel sided primary excavation about two figths distance to base, and further excavated by a V-shaped median notch with its posterior angles roundly produced.

Genitalia: Female seventh sternum about five twelfths as long as wide, lateral angles strongly converging from base, posterior lateral angles very slightly convex with an abrupt wide primary excavation about two fifths distance to base and with two median acute lobes at bottom of excavation separated by a deeper V-shaped secondary notch. Male in lateral view: Pygofer almost rectangular, upper margins posterior half sloping downward posteriorly to a rather projected upper posterior corner, greatest width seven elevenths length. Aedeagal base inclined dorsoposteriorly, length almost half aedeagal length, preatrium curving upward from

articulation as a "sickle handle" to shaft; aedeagal shaft with basal width of third base length, posteriorly directed, deepening on proximal half, then curving dorsad and anteriorly as a tapering apical half to a rather blunt apex. Connective ventral shaft stout, posteriorly directed, with bladelike form, curving upward and deepening on apical half and terminating with upturned sharp point, a slight rounded concavity on dorsal margin of apical sixth. In dorsal view: Aedeagus widest at articulation, tapering to bifid apex, lateral apodemal horns moderately long and tapering. Connective Y-shaped with arms thickened on apical half; shaft broadened at articulation, then gradually narrowing along apical half to apex, its length twice arm length.

Types: Lectotype male, Fort Collins, Colorado, Oct. 12, 1898, here designated, and 13 syntypes, Wray and Fort Collins, Colorado, and Kimball, Nebraska, all in collection of E. D. Ball, deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Wyoming) Wheatland, July 14, Lusk, July 14; (Colorado) Garden of the Gods, Aug. 19; (Kansas) Meade County.

Notes: Range, in northern states along eastern edge of Rocky Mts. Some variableness exists in width of median excavation. *T. marmor* Sanders and DeLong was thought to be a variation (Ball 1931). However the male genitalia is not similar to that of *graphicus.*

28. *Texananus* (*Texananus*) *constrictus* sp. nov.

Resembling *Texananus* (*Texananus*) *arctostaphylae* (Ball) but body slightly shorter, posterior and anterior margins of crown almost parallel, male connective ventral shaft moderately broad, widened on apical half as it gently curves upward and tapers to a short apex in lateral view. Length 6 mm.

Structure: Robust form. Crown wide, about one fourth longer at middle than next to eye, rather angulate with front. Clypeus slightly longer than basal width, evenly convex. Clypellus constricted subbasally, wider at apex. Pronotum with posterior and anterior margins almost parallel, rugose on posterior half. Elytra broad and rounded apically.

Color: Dorsum uniformly covered with dark brown, rather dense vermiculate lines. Crown with pair brown spots at base, its margin yellowish. Clypellus very dark brown with yellowish spots, small broken arcs laterally. Pronotum blotched with brown. Scutellum

with pair of brown spots. Elytra with cells uniformly filled with brown vermiculate lines.

Genitalia: Female seventh sternum about one third as long as wide, lateral margins converging roundly to the excavations on posterior margin which consist of a deep V-shaped median excavation with lateral posterior notches at posterior margin of excavation, the form hardly distinguishable from seventh sternum of *arctostaphylae*. Male valve triangular, apex rounded. Plates broadest on proximal half, rapidly narrowing to apices near mid line. Male in lateral view: Pygofer rather rectangular, narrowing posteriorly, greatest width about equal to length. Aedeagal base dorsoposteriorly directed, its length about one half aedeagal length, preatrium curving upward as a short "sickle handle" to shaft; aedeagal shaft with basal width of about half base length, posteriorly directed on proximal half, then curved dorsad, tapering to a bifid apex. Connective ventral shaft broad, curving slightly upward to a bluntly sharpened apex, constricted at middle. In dorsal view: Aedeagus widest at articulation, apodemes prominent, tapering at point of curving dorsad.

Types: Holotype male, allotype female, seven male and four female paratypes, Granite Dell, Arizona, Aug. 14, 1935, R. H. Beamer; three male and one female paratypes, Granite Dell, Arizona, Oct. 29, 1906, E. D. Ball; four male and one female paratypes, Granite Dell, Arizona, June 29, 1933, P. W. Oman. Holotype, allotype and paratypes deposited in Snow Entomological Collections, University of Kansas; paratypes in U. S. National Museum.

Material studied: Only type material.

Notes: Range, in Arizona.

29. *Texananus* (*Texananus*) *marmor* Sanders and DeLong

Texananus marmor Sanders and DeLong, Proc. Ent. Soc. Washington, vol. 25, 1923, p. 152.

Resembling *cumulatus* in body form and colorations but robust with sparse irrorations, lobate commissural line distinct, dark bands across anterior part of both the pronotum and scutellum; connective ventral shaft, in lateral view, moderately wide with apical third slightly swollen and gently turned dorsad as it tapers to a sharpened apex; female seventh sternum with posterior half of lateral margins strongly converging and posterior margin excavated with a median V-shaped notch halfway to base, posterior corners with notches rounding to adjacent margins.

Genitalia: Female seventh sternum two fifths as long as wide,

lateral margins on basal half parallel, then strongly converging to posterior margin with a median V-shaped excavation halfway to base, with posterior rounded notches lateral to excavation corners. Male in lateral view: Pygofer rectangular, dorsal and ventral margins converging behind, upper posterior corner as a slightly dorsally turned lobe, lower corner rounded, greatest width about four fifths length. Aedeagal base inclined dorsoposteriorly, its length about two fifths as long as aedeagal length, concave with lower marginal two thirds, curving anteriorly along the stout preatrium to articulation; aedeagal shaft with basal width about third base length, posteriorly directed, slightly enlarging on basal third, then tapering as it curves dorsad and slightly anterior into a slender apical portion, apex truncate. Connective ventral shaft posteriorly directed, slightly curved dorsad and swollen on apical fourth. In dorsal view: Aedeagus widest anteriorly at articulation, narrowed anterior to lateral apodemes, then tapering to apex. Connective Y-shaped, arms paralleling each other; shaft narrowed beyond arm, widening at articulation, then tapering to apex.

Types: Cotypes, ten in number, Onah, Manitoba, July 24, 1919, Norman Criddle, deposited in collections of Dr. D. M. DeLong. Types studied.

Material studied: (Manitoba) Onah, Sept. 18.

Notes: Known only from the Canadian Province Manitoba, and collected from "Juniperus horizontalis."

30. *Texananus* (*Texananus*) *cumulatus* (Ball)

Phlepsius cumulatus Ball, Canadian Ent., vol. 32, 1900, p. 202.
Phlepsius notatipes Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 343.

Resembling *arctostaphylae* in body form and coloration but with crown narrower, lighter in color and lobate commissural line faint; connective ventral shaft in lateral view slender to a slightly upturned and swollen apical portion which tapers quickly to a sharpened apex; female seventh sternum strongly converging posteriorly from base, with a deep V-shaped excavation two thirds distance to base, and with rounded notches at posterior lateral margins of excavation.

Genitalia: Female seventh sternum about one third as long as wide, lateral margins strongly converging posteriorly from base, posterior margin with broad V-shaped excavation between lateral angles, excavation width about three fifths length sternum with small notch on posterior fourth of margins. Male in lateral view:

Aedeagal base nearly upright, shortest length about half aedeagal length, its lower marginal third curving anteriorly along the preatrium to articulation; preatrium curves upward to basal part of shaft; aedeagal shaft "sickle-shaped" with basal width of about fourth aedeagal length, tapering to apex as it curves dorsally and anteriorly terminating in a bifid apex. Connective shaft deepened at aedeagal articulation, posteriorly directed as a slender process terminating in a slightly upturned and swollen apical third. In dorsal view: Aedeagus wider basally than along tapering apical portion; lateral apodemes long and slender. Connective Y-shaped with arms almost parallel; shaft about twice arm length.

Types: Lectotype male, Fort Collins, Colorado, Aug. 8, 1898, here designated and syntypes Fort Collins, Virginia Dale, Pinewood, and Livermore, Colorado in collection of E. D. Ball, deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Nebraska) Glen Sioux Co.; (Montana) Bennett, Three Forks, White Hall; (Utah) Granite, Bountiful, Soldier Summit, Heber; (Colorado) Fort Collins, Glenwood Springs.

Notes: Range, in western mountain states. *P. notatipes* Osborn and Lathrop represents a common variation in the female segment (Ball 1931). This is a typical heath species found on mats of *Arctostaphylos* (bearberry) which forms a herbaceous ground layer in coniferous forests, according to DeLong (1926).

31. *Texananus* (*Texananus*) *arctostaphylae* (Ball)

Phlepsius cumulatus var. *arctostaphylae* Ball, Canad. Ent., vol. 32, 1900, p. 202.

Resembling *cumulatus* in body form and coloration but with broader crown and with darker irrorations; connective ventral shaft in lateral view moderately slender, tapering very slightly to the pointed apex; female seventh sternum with lateral margins extremely converging from base and with a median V-shaped excavation bordered posteriorly by rounded notches abruptly cut from adjacent posterior margin.

Genitalia: Female seventh sternum about one third as long as wide, lateral margins converging roundly to the excavations on posterior margin, posterior margin with primary excavation on middle third appearing as a pair of lateral notches to a deep median V-shaped excavation reaching three-fifths distance to base. Male in lateral view: Pygofer somewhat rectangular with posterior margin convex to a blunt point, upper margin sinuous, greatest width

about three-fourths its length. Aedeagal base dorsoposteriorly directed, its length about two fifths aedeagal length, preatrium curved dorsad as a "sickle handle" for the sicklelike shaft; aedeagal shaft with basal depth of about half base length, posteriorly directed, expanding on proximal third, then tapering to a bifid apex as it curves dorsad and anteriorly, in a sickle-like structure. Connective ventral shaft posteriorly directed as a slender shaft scarcely tapering to an abruptly pointed apex. In dorsal view: Aedeagus widest at articulation, slightly narrow toward the slender lateral apodemes, then tapering to the slender shaft. Connective Y-shaped with arms rather parallel but swollen laterally on apical half, tapering to the apices; shaft stout, widening at articulation, then tapering to sharp apex; its length about twice arm length.

Types: Lectotype female Dtch Geo., Colorado, Aug. 11, 1899, here designated, and syntypes in collection of E. D. Ball deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Manitoba) Mafeking, Aug. 3, Russel, Aug. 1, Deepdale, Aug. 1, Birch River, Aug. 3, Hartney, July 31; (Wisconsin) Brule, Aug. 16; (Minnesota) Itasca Park, Aug. 11; (North Dakota) Tokio, July 28, Leonard, July 26.

Notes: Range, in North Central states and central Canada. Externally this form appears much like *T. cumulatus,* but the connective ventral shaft, aedeagus, and shape of pygofer distinguishes it from that species.

32. *Texananus* (*Texananus*) *monticulus* DeLong

Texananus monticolus DeLong, Bull. Brooklyn Ent. Soc., vol. 38, 1943, p. 125.

Resembling *cumulatus* in form and coloration but broader, and paler in color; connective ventral shaft in lateral view moderately stout, very slightly tapering as it curves strongly dorsad on apical half to a pointed vertex; female seventh sternum with lateral margins roundly converging from base, and with moderately narrow median V-shaped excavation with large lateral rounded notches at posterior border of median excavation forming acute produced points with excavation border.

Genitalia: Female seventh sternum about one third as long as wide, lateral margins roundly converging from base, posterior lateral angles slightly produced, posterior margin convex with a wide primary excavation on middle third, its depth about one fifth sternum length and a median deep narrow excavation over half way to base, its corners acute. Male in lateral view: Pygofer

somewhat rectangular, upper and lower margins converging slightly from anterior margin, posterior margin sloping dorsoposteriorly to an acute upper posterior corner. Aedeagal base inclined dorsoposteriorly its length about one third aedeagal length, angularly concave with lower marginal two thirds curving anteriorly along the preatrium to articulation; aedeagal shaft with basal width of half base length departing posteriorly from about middle of base, slightly widening on proximal half, then tapering as it curves dorsally and slightly anteriorly to a narrow apex. Connective ventral shaft posteriorly directed, curves strongly dorsad, on apical half, at about sixty degree angle from horizontal to a sharp apex. In dorsal view: Aedeagus broadest at articulation, narrowing slightly anterior to expanding slender lateral apodemes, then tapering to apex. Connective oddly Y-shaped, arms short, converging anteriorly; shaft broad on basal fourth, narrowed to half base width on fourth portion anterior to articulation, then tapering to shaft apex; its length about four times arm length.

Types: Holotype male, paratype male, Jemez Springs, New Mexico, June 15, 1919. Allotype female and male paratype, Salina, Utah, July 24, 1930, E. W. Davis. Types deposited in collection of Dr. D. M. DeLong.

Material studied: (Utah) Cove, Aug. 14; (Arizona) Ashfork, Aug. 6.

Notes: Range, in several Rocky Mountain States. It has been collected from *Quercus utahnus.*

33. *Texananus* (*Texananus*) *proximus* sp. nov.

Resembling *Texananus* (*Texananus*) *lathropi* (Baker) in external form and coloration but connective ventral shaft broader basally, tapering and curved strongly dorsad on apical half, apex of style narrowing to rounded apex and turned outward. Length 5.75 mm.

Structure: Crown narrow, one half longer at middle than next to eye, slightly convex, bluntly rounded with front, apex subconical in dorsal view. Clypeus rather evenly convex, roundly wedge-shaped, length one third longer than basal width. Clypellus about as wide basally as subapically, constricted slightly along middle. Pronotum, rogose posteriorly, anterior and posterior margins almost straight, only slightly rounded outward. Elytra with posterior margin of costal border not strongly curving mesad, apex broadly rounded, appendix relatively wide.

Color: Crown, pronotum, and scutellum yellowish to stramineous with irregular brown markings dotted with yellowish spots, brown

spots behind eyes on pronotum and regularly placed brown spots on scutellum. Clypeus darkly embrowned with lateral yellowish arcs and with median spots from base to apex. Clypellus with paired quadrangular brown spots at base, continuous ventrally with a median pair of streaks to beyond middle. Elytra milky white or hyaline with brownish vermiculate or irrorate markings in cells, distinct ivory trilobate commissural line. Several brownish costal spots slightly tinged with rosaceous.

Genitalia: Female not known. Male valve triangular, length half width, apex obtusely sharp. Plates roundly broad on basal half, lateral margin rapidly narrowing and almost paralleling valve sides to narrow slightly produced apical lobes. Male in lateral view: Pygofer somewhat rectangular but dorsal and ventral margins converging posteriorly to half width at anterior border, greatest width about two thirds length. Aedeagal base dorsoposteriorly directed, its length five sevenths aedeagal length, concave on lower margin with marginal third curving anteriorly along preatrium to articulation, preatrium curving upward as a "sickle handle" to shaft; aedeagal shaft with basal width of one fifth base length, directed posteriorly, then tapering as it abruptly curves anterodorsally to apex. Connective ventral shaft broad at articulation, then tapering to apex, apical half curving dorsad at about sixty degree angle from horizontal. In dorsal view: Aedeagus broadest at articulation, constricted anterior to short lateral apodemes, narrowed strongly on shaft proximal third to slender apical two thirds.

Types: Holotype male and one paratype male, Wenatchee, Washington, Aug. 12, 1918, E. D. Ball; three paratype males, Moab, Utah, Aug. 10, 1906. Holotype and paratypes deposited in the U. S. National Museum; a paratype in Snow Entomological Collections, University of Kansas.

Material studied: Only type material.

Notes: Range, in northwestern states.

34. *Texananus* (*Texananus*) *bialtus* DeLong

Texananus bialtus DeLong, Pan Pacif. Ent., vol. 14, 1938, p. 185.

Resembling *latipex* in form and coloration but irrorations more distinct; aedeagal shaft, in lateral view, not bifid at apex and male valve much shorter in length than width; connective ventral shaft in lateral view tapering and slightly curving upward to sharpened apex.

Genitalia: Female as yet not known. Male in lateral view: Pygofer angularly rectangular, greatest depth about three fourths length, upper posterior corner rounding, lower margin from its

middle point sloping upward posteriorly to a blunt convexity on posterior margin. Aedeagal base inclined posteriorly, length about five ninths aedeagal length, its lower marginal fourth curving anteriorly along preatrium to articulation; preatrium curving upward as a "sickle handle" to sicklelike shaft; aedeagal shaft with basal width about one third base length, departs upper basal portion, tapering as it curves posteriorly dorsad and somewhat anteriorly terminating in almost straight slender apical third. Connective shaft posterior to aedeagal articulation uniformly tapering to a sharpened apex with a slight curving upward. In dorsal view: Aedeagus widest basally tapering to apex. Connective Y-shaped with arms closely paralleling; shaft broad at arm, base narrowing rather uniformly along a stout apical portion to an abruptly sharpened apex, its length about two thirds longer than arm length.

Types: Holotype male, Davis Mountains, Texas, August 22, 1936, J. N. Knull, deposited in collection of Dr. D. M. DeLong. Type studied.

Materials studied: Only type material.

Notes: Range, in Davis Mountains, Texas.

35. *Texananus* (*Texananus*) *validus* sp. nov.

Resembling *sextus* in coloration and general body form, but vertex of crown not rounded, coloration of face more sparse, female primary excavation of seventh sternum slightly smaller, and male connective ventral shaft curved slightly upward on apical sixth. Length 6 mm.

Structure: Crown rather narrow, flat, slightly angulate with front, its length about one third longer at middle than next to eye. Clypeus wedge-shaped, evenly convex, about two-sevenths longer than width at base, apex abruptly tapered. Clypellus roundly constricted on basal two thirds, widened slightly apically. Pronotum rather angularly extended anteriorly between eyes, anterior and posterior margins almost straight. Elytra rather broad, ovate in dorsal over-all view, apices truncately rounded.

Color: Dorsum irregularly marked with vermiculate and irrorate lines. Crown with semblance of a band between eyes, anterior portion yellowish with a few brown spots. Clypeus irrorate with brown on basal half, with lateral brownish arcs on apical half, yellowish streak along midline. Clypellus with pair of brown basal spots, a slender rectangular outline of brown on basal half. Pronotum blotched with brown usually distinct and paired anteriorly. Elytral cells sparsely marked with vermiculate and irrorate colora-

tion, commissural line with trilobate ivory-white areas, rather frequent small costal spots and larger spots in apical cells, pronounced brown areas at posterior end of claval veins.

Genitalia: Female seventh sternum about one third as long as wide, lateral margins strongly converging from base to a semicircular primary excavation on the middle third of posterior margin, with a median notch, its bottom reaching about half way to base. Valve somewhat triangular, apex rather acute. Plates broadest at base, their lateral margins converging to apical third which is rapidly tapered to rounded apex. Male in lateral view: Pygofer somewhat rectangular, dorsal and ventral margins sinuously converging posteriorly, posterior margin as a convex, bluntly pointed apex, greatest depth about five eighths its length. Aedeagal base dorsoposteriorly directed, its length about two thirds aedeagal length, concave below with lower one third curving anteriorly along the preatrium to articulation, preatrium curving upward in a moderately long sickle handle to shaft; aedeagal shaft sickle-shaped, with basal width of about one sixth base length, posteroventrally directed, slightly tapering as it curves dorsally and slightly anterior to a truncate apex. Connective ventral shaft broad at articulation, posteriorly directed, tapering to an apical sixth slightly turned dorsad to a sharpened point. In dorsal view: Aedeagus broadest at articulation, constricted on posterior half of base, then expanded to short lateral apodeme processes, shaft slender, tapering to slightly bifid apex.

Types: Holotype male, allotype female, and one male paratype, San Catalina Mts., Arizona, July 17, 1930, E. D. Ball; other paratypes, one male, Atascosa Mts., Arizona, Sept. 29, 1935, E. D. Ball; one male, Patagonia, Arizona, Aug. 8, 1932, E. D. Ball. Holotype, allotype and paratypes deposited in the U. S. National Museum; a paratype in Snow Entomological Collections, University of Kansas.

Material studied: Only type material.

Notes: Range, in Arizona Mountains.

Synopsis of the Subgenus EXCULTANUS Oman

Texananus subgenus *Excultanus* Oman, Memoirs Ent. Soc. Washington: No. 3, 1949, p. 142.

Originally described as follows:

"In addition to the characters indicated in the key, members of this subgenus have a characteristic aedeagus, U-shaped in lateral view, the terminal portion acuminate, the basal portion much expanded laterally. Also, the male plates are broadly triangular."

Additional characters in subgeneric key.

KEY TO THE SPECIES OF TEXANANUS (EXCULTANUS) OMAN

1. Apex of male pygofer bluntly rounded, about length of plates posteriorly. Female seventh sternum with visible portion of posterior underlying membranes rectangular, extending from median excavation to lateral margin ..... 36. *dorothyi*

Apex of male pygofer almost sharply rounded. Female seventh sternum with visible portion of paired underlying membranes triangular or oval, not showing all the way to lateral margin 2

2.(1) Male pygofer apex extending much beyond plate apices, with conspicuous innerapical brush of bristles. Female seventh sternum roundly and broadly excavated nearly to base, visible part of underlying membranes showing only as rounded lobes on middle of excavation margin 3

Male pygofer apex about even with apex of plate, without apical brush. Female seventh sternum with underlying pair of membranes triangular, usually not showing beyond posterior lateral angles ..... 37. *excultus*

3.(2) Male pygofer apical brush about as wide as length of hairs. Aedeagus usually articulated near apodeme for membrane attachment and not greatly enlarged, posterior lateral angles rounded. Female seventh sternum with posterior lateral angles acute ..... 38. *incurvatus*

Male pygofer apical brush much wider than length of hairs. Aedeagal articulation distant from apodeme projection and much enlarged posterior to articulation. Female seventh sternum with posterior lateral margin concavely truncate, 39. *neomexicanus*

36. *Texananus (Excultanus) dorothyi* DeLong

Texananus dorothyi DeLong, Anal. Exc. Nac. Cien. Biol., vol. 1, 1939, p. 387.

Resembling *excultus* in body form and coloration but narrower with more pointed crown apex; male pygofer shorter and its posterior margin rounded; female seventh sternum short with pair of underlying plates visibly extending posteriorly from margins of median excavation to lateral margins.

Genitalia: Female seventh sternum about third as long as wide, lateral margins about parallel, converging on posterior third, and continuous along lateral margin of underlying plate, which is concavely rounded on posterior margin and widely excavated to seventh sternum, posterior lateral angles of seventh sternum acute and posterior margin widely excavated almost to base. Male in lateral view: Pygofer, scarcely triangular, upper and lower margins rounding strongly above and below on their middle, posterior angle a bluntly rounding point, shorter than plate apices posteriorly. Aedeagus,

horseshoe-shaped and opened above; aedeagal base upright length almost equal aedeagal shortest length, with no apparent preatrium. In dorsal view: Aedeagal base much wider than slender curved shaft, and rounding above; from articulation shaft tapers to apex. Connective Y-shaped; shaft strongly widened on posterior half, its length about half arm length.

Types: Holotype male and allotype female, Wickenburg, Arizona, June 16, 1937, D. J. and J. N. Knull. Paratype male and female specimens, Prescott National Forest, Arizona, June 2, 1937; Haulpai Mountains, Arizona; Huachuca Mountains, Arizona; Tucson, Arizona; Davis Mountains, Texas; Santa Rita Mountains, Arizona; Chiricahua Mountains, Arizona; Gillespie County, Texas; Uvalde, Texas; Brownsville, Texas, all collected by Dorothy J. and J. N. Knull, 1934 to 1938 inclusive. Male paratype, Atencingo, Puebla, Mexico, July 19, 1930, Dampf. Types deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (New Mexico) White Sands, June 30; (Arizona) Patagonia, July 29, Pima Co., Baboquivari Mts., July 24, Santa Rita Mts., Aug. 1, Oak Cr. Canyon, Huachuca Mts., July 9, Mescal, July 28, Tucson, Aug. 16, Pearce, Granite Dell, Mustang Mt., Ajo, Yarnell, Cochise Co., Arivaca, July 26.

Notes: Range, in mountain regions of Arizona across New Mexico and parts of Texas. The body form of *T. excultus* as found in Texas is more similar to *T. dorothyi* than the stouter more typical *excultus* of the southeast.

37. *Texananus* (*Excultanus*) *excultus* (Uhler)

Jassus excultus Uhler, Bull. U. S. Geol. & Geog. Surv., 3: 1877, p. 467.
Jassus infumatus (Van Duzee), Catalogue of the Homoptera, vol. 2: 1917, p. 667.
Jassus scalaris (Van Duzee), Catalogue of the Homoptera, vol. 2: 1917, p. 667.

Resembling *dorothyi* in body form and coloration but with wider body and crown and coloration more distinctly dark, trilobate commissural line contrasting; male pygofer in lateral view slightly longer and pointed at its posterior margin; female seventh sternum longer on outer margin with posterior lateral angles produced even with lateral posterior margin of the pair of underlying plates.

Genitalia: Female seventh sternum about one third as long as wide, lateral margins roundly converging from base, posterior margin sinuously excavated between lateral margins almost to base, outer marginal third of excavation concave, borders of lateral underlying membranes median to but not produced posteriorly beyond lateral angles. Male in lateral view: Pygofer rather triangular with

dorsal and ventral margins rounding and posterior apex as a sharpened lobe, greatest width about half length. Aedeagal base about upright convex, its length almost aedeagal length, no preatrium; aedeagal shaft continuous ventrally with basal portion of aedeagus, tapering as it curves posteriorly and dorsally to a slender apex near basal apodeme. In dorsal view: Aedeagus broadest along length of upright base above aedeagal attachment, then tapering to apex. Connective Y-shaped; shaft expanding apically, its length half arm length.

Types: Cotypes in the Uhler Collection deposited in the U. S. National Museum.

Material studied: (Virginia) Virginia Beach, Aug. 11; (Georgia) Okefenokee Swamp, July 30; (Florida) Lacoochee, July 7, Deerfield, July 26, Dade Co., Aug. 16, Long Key, July 23, Marianna, March 17, Ft. Lauderdale, April 15, Gainesville, Apr. 28, Morrison Field, Nov. 3, Iverness, Feb. 4, Farmdale, June 27, Hilliard, Aug. 31, Montbrook, Feb. 4, Fruitville, Aug. 11, Everglade, Aug. 11, Ft. Meade, Aug. 13, Homestead, July 19; (Alabama) Prattsville, Aug. 21, Birmingham, Aug. 26, Burnsville, July 20, Crawford, July 24, Marian Jct., July 16; (Mississippi) Leland, Sept. 15, Woodville, July 6, Biloxi, Aug. 4, Port Gibson, June 27, Pascagoula, Aug. 8, Ireland, July 8, Meridian, July 17; (Missouri) Noel, July 4; (Louisiana) Denham Springs, July 20, Madison Parish, July 7; (Arkansas) Polk Co., July 21, Folk, Dec. 21, Cove, June 21, Aloha, Dec. 23; (Texas) Old Ocean, Jan. 3, Angleton, Jan. 3, Concan, Apr. 14, Brooks Co., July 25, Progresso, July 1, Brazoria Co., Aug. 10, Orange Co., July 14, Harris Co., July 28, Jim Wells Co., July 24, Cameron Co., July 3, Houston, Feb. 4.

Notes: Range, in southern states. Some Texas specimens are found intergrading in body size and form with *T. dorothyi*. *J. infumatus* and *J. scalaris* are manuscript names only. A meadow species of southern states according to DeLong (1926).

38. *Texananus* (*Excultanus*) *incurvatus* (Osborn and Lathrop)

Phlepsius incurvatus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 346.

Resembling *neomexicanus* in body form and coloration but slightly shorter and with trilobate commissural line slightly distinct; male pygofer in lateral view with greatest depth at least two-thirds length, brush at inside posterior apex of pygofer smaller; female seventh sternum with posterior lateral angles roundly pointed and continuous with the broad rounded median excavation.

Genitalia: Female seventh sternum almost half as long as wide, lateral margins roundly converging from base to rather pointed posterior lateral angles, between which the posterior margin is excavated roundly almost to base, underlying lobes visible on middle of excavation margins. Male in lateral view: Pygofer parallelogram-shaped, upper posterior corner extended with inner brush of recurved hairs, greatest vertical width about two thirds horizontal length. Aedeagal base short anterodorsally inclined, length about one-fourth aedeagal length; aedeagal shaft continuous with basal portion posteroventrally directed widening posteriorly then tapering as it curves dorsad and back anteriorly as a straight slender apical third almost paralleling proximal portion. In dorsal view: Aedeagus quadrangular basally, tapering posteriorly beyond aedeagal articulation all the way to the slightly bifid apex. Connective Y-shaped; shaft length about two thirds arm length, apical third expanded.

Types: Cotypes, one male and one female in Van Duzee Collections deposited in California Academy of Science. Paratype female, Sabino Canyon, Catalina Mountains, Arizona, and paratype female, Imperial County, California, R. Hopping, both in Van Duzee Collections. Specimens compared with type by Dr. E. S. Ross.

Material studied: (New Mexico) Organ, July 3; (Arizona) Tucson, Aug. 16, Baboquivari, July 19, Arivaca, July 26, Hereford, Aug. 22, Pearce, Aug. 23, Sabino Canyon, July 7, Mescal, July 28, Vail, July 18, Patagonia, July 29, Tubac, Aug. 21.

Notes: Range, in southwestern states, frequently collected in Arizona. The aedeagal structure is similar to structure found in *neomexicanus, dorothyi* and *excultus.*

39. *Texananus* (*Excultanus*) *neomexicanus* (Baker)

Phlepsius neomexicanus Baker, Psyche, vol. 7, 1895, p. 13 (Suppl.),

Resembling *incurvatus* in body form and coloration but slightly longer with uniform brownish coloration; male pygofer in lateral view larger and longer with greatest depth about one half its length, brush broad on inner margin of moderately broad posterior apex of pygofer; female seventh sternum with projected acute points at posterior lateral corners of the large median excavation, these projections median to rounded posterior lateral angles of sternum.

Genitalia: Female seventh sternum five-twelfths as long as wide, lateral margins nearly parallel, posterior lateral angles very slightly

produced, posterior margin excavated by a very large rounded V-notch almost to base with underlying plate margins showing on either side of excavation. Male in lateral view: Pygofer somewhat parallelogram in shape, greatest depth almost half length, upper posterior angle extended posteriorly with a brush of hairlike spines directed posteriorly from inner surface of corner. Aedeagus rather "horseshoe" shape, base about upright, its length about equalling aedeagal length from articulation; aedeagal shaft continuous below with basal portion curving posteriorly to an abrupt curving upward, tapering as it curves dorsoventrally as a slender half terminating near dorsal base border. In dorsal view: Aedeagus broad basally, gradually diminishing to apex. Connective Y-shaped with slender arms; shaft slender on anterior half but greatly swollen apically, its length about arm length.

Types: Holotype male, San Augustine Ckll. 2123 in collection of C. F. Baker deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Texas) Kendall Co., Palopinto County; (New Mexico) White's City, July 13, Hope, July 13; (Arizona) Patagonia, July 29, Baboquivari Mts.

Notes: Range, in the Southwest. This species is close to *T. incurvatus* in appearance.

Synopsis of the Subgenus IOWANUS Ball

Phlepsius subgenus *Iowanus* Ball, Ann. Ent. Soc. Amer., vol. 11, 1918, p. 382.

Originally described as follows:

"Resembling *Phlepsius* but with head much narrower than pronotum, vertex narrow, disc flat, front long and narrow, but slightly widening above. Pronotum large, pushed forward between the eyes, the lateral margins long and strongly oblique. Elytra very long and narrow, over one third their length beyond clavus; central apical cell long curved, narrower at base. Surface of elytra regularly inscribed with vermiculate lines.

"Type of subgenus *Phlepsius* (*Iowanus*) *handlirschi* Ball."

A hooklike spine on pygofer, and a posterior lobe at upper posterior corner. Additional characters in subgeneric key.

KEY TO THE SPECIES OF TEXANANUS (IOWANUS) BALL

1. Connective ventral shaft apical two thirds divided into a pair of long slender processes. Male pygofer posterior lobe elongate and rather tapering to rounded apex. Female seventh sternum with lateral angles and middle slightly produced with narrow median notch about half way to base ..... 40. *lyratus*

Connective shaft cleft on apical portion and curved ventrad. Male pygofer lobes of various shapes and female seventh sternum not as above 2

2.(1) Connective shaft apical third cleft and bent abruptly ventrolaterally as nearly straight, tapering, processes. Male pygofer lobe long, ovate, slightly constricted basally. Female seventh sternum with lateral angles roundly produced, median produced pair of teeth separated by a V-shaped notch ..... 41. *majestus*

Connective shaft apical cleft portion less than third of shaft in length. Male pygofer and female seventh sternum not as above 3

3.(2) Apical portion of connective shaft sharply bent ventroposteriorly as slightly curved processes much longer than width of shaft at division in dorsoventral view. Male pygofer lobe not constricted at base 4

Apex of connective shaft curved ventrolaterally, or ventrad, in a pair of beaklike processes about as long as width of shaft at division in dorsoventral view. Male pygofer lobe constricted at base 5

4.(3) Apical portion of connective shaft curved ventroposteriorly and sharply bifid in lateral view. Male pygofer lobe almost rectangular, apex almost truncate ..... 42. *dicentrus*

Apical fourth of connective shaft bent ventrad as nearly straight processes, their sharp apices turned further ventrad. Male pygofer lobe slightly tapering to rounded apex. Female seventh sternum slightly produced at middle and laterally, with wide, almost U-shaped median notch about half way to base ..... 43. *caducus*

5.(3) Apex of connective shaft turned ventrad a distance of width of shaft in dorsoventral view. Male pygofer lobe somewhat spherical, constricted at its base. Female seventh sternum lateral angles strongly produced beyond median teeth separated by a narrow notch half way to base, 44. *bullatus*

Ventrally bent portion of apex of connective shaft twice as long as lateral width of shaft at bend. Male pygofer lobes elongate, ovate, slightly constricted at its base. Female seventh sternum with lateral angles and posterior middle roundly produced with narrow median notch halfway to base ..... 45. *longipennis*

40. *Texananus* (*Iowanus*) *lyratus* DeLong and Hershberger

Iowanus lyratus DeLong and Hershberger, Ohio Jour. Sci., vol. 48, 1948, p. 107.

Resembling *majestus* in body form and coloration but with slightly wider crown and somewhat paler brownish coloration; connective ventral shaft with distal two thirds divided into a pair of tapering processes; male pygofer lobe slightly tapering to rounded

apex; female seventh sternum with posterior lateral angles produced about even with pair of produced median lobes separated by a narrow notch which reaches halfway to base.

Genitalia: Female seventh sternum about three sevenths as long as wide, lateral margins sinuously and slightly converging from base, posterior lateral angles slightly produced about even with median pair of lobes separated by a deep slender notch half way to base. Male in lateral view: Pygofer irregularly trapezoidal in shape, upper margin length about half that of the lower rounding margin; posterior lobe long, tapering, arising at lower base of lobe, a hook curves mesad and posteriorly. Aedeagal shaft dorsoposteriorly directed, its length almost two thirds aedeagal length, its lower marginal third curving anteriorly along the preatrium to articulation; aedeagal shaft from lower basal half is posteriorly directed, rapidly diminishing on lower fourth, then curving dorsad slightly, tapering to a short, posteriorly directed apex. Connective shaft posteriorly directed, broadest on proximal third, then suddenly reducing in size and dividing into a pair of dorsoposteriorly directed processes. In dorsal view: Aedeagus with base widest at articulation, tapering posteriorly to apodemal process; shaft slender to apex. Connective Y-shaped, arms roundly separated; shaft wide at base, tapering to division into a pair of slightly diverging slender processes.

Types: Holotype male, Atlanta, Ga., Sept. 14, 1939, allotype female, same locality, August 27, 1939, and paratype male, same locality, September 2, 1939, P. W. Fattig, deposited in collection of Dr. D. M. DeLong. Type studied.

Material studied: (Alabama) Tuskegee, July 22; (Arkansas) Polk County, July 21.

Notes: Range, in southern and eastern states.

41. *Texananus* (*Iowanus*) *majestus* (Osborn and Ball)

Phlepsius majestus Osborn and Ball, Proc. Acad Sci., vol. 5, 1897, p. 229.
Texananus borrori DeLong, Ohio Jour. Sci., vol. 39, 1939, p. 237.

Resembling *longipennis* in body form and coloration but slightly more robust and color markings somewhat reddish brown; connective ventral shaft in lateral view stout on proximal posteriorly curving half, then constricted subapically to the ventrolaterally directed apex, cleft into a pair of long ventral beaks at right angles to main shaft; female seventh sternum with moderately produced rounded posterior lateral angles and with strongly produced pair of median teeth separated by a large V-shaped notch about halfway to base.

Genitalia: Female seventh sternum about half as long as wide, lateral margins almost parallel, posterior lateral angles roundingly produced, posterior margin with pair of median acutely produced teeth separated by a deep narrowed V-shaped notch extending half way to base. Male in lateral view: Pygofer somewhat trapezoidal in shape, upper margin only half that of ventral margin, greatest width about two thirds length, neglecting posterior lobe; at upper posterior corner an oblong lobe arises and extends posteriorly, a stout hook curving inward and downward, arises below base of lobe. Aedeagal base lying horizontal, length about half aedeagal length; aedeagal shaft with basal depth about one fifth aedeagal length, posteroventrally directed and tapering as it curves posteriorly on proximal fourth and then obliquely upward to a slender apex near base of posterior pygofer lobe. Connective shaft deepest at aedeagal articulation, stout, posteroventrally directed on proximal third, then curving posteriorly to a constricted apical fourth beyond which apex is cleft into pair of long ventrally directed beaks, their length about half aedeagal base length. In dorsal view: Aedeagus widest basally, narrowing on proximal half to a slender shaft below, apex deeply cleft; apodemal portion narrowed posteriorly to blunt apex. Connective somewhat Y-shaped with arms angularly sinuous, paralleling each other; shaft narrowing from widened arm base to a stout ventral portion; its apex cleft with tapering processes diverging, shaft length about a third longer than arm length.

Types: Lectotype male, Ames, Iowa, July 30, 1896, in Iowa State College Collections designated by P. W. Oman (1946). A syntype female, Ames, Iowa, Aug. 18, 1893, E. D. B. had abdomen missing but is apparently *P. majestus.* Types of the *T. borrori* DeL. were studied in collection of Dr. D. M. DeLong and are identical with *majestus.*

Material studied: (Michigan) Oakland County, Aug. 24, Cedar River, Aug. 26; (Wisconsin) Rib Mountain St. Park; (Maryland) Plummer's Island, Nov. 1.

Notes: Range, in the north central states eastward. The female from Plummer's Island, Maryland, appears typical but considerably eastward in locality.

42. *Texananus* (*Iowanus*) *dicentrus* DeLong

Texananus dicentrus DeLong, Ohio Jour. Sci., vol. 39, 1939, p. 236.

Resembling *caducus* in body form and coloration but connective ventral shaft with apical fifth sharply curved obliquely ventrad to a bifid apex in lateral view.

Genitalia: Female not known. In lateral view: Pygofer rather trapezoidal, dorsal margin about two-thirds as long as ventral margins converging rapidly to a posteriorly directed lobe slightly tapering to rounded apex, a hook arising from below base of lobe curves mesad. Aedeagal base dorsoposteriorly directed, its length slightly more than half aedeagal lenth; aedeagal shaft with basal width of third base length is posteroventrally directed, tapering proximally, then shaft curves dorsally in rather straight apical two thirds, apex slightly curved posteriorly. Connective ventral shaft posteriorly directed, apical fifth sharply turned obliquely ventrad, apex bifid. In dorsal view: Aedeagus base broadest at articulation, slightly narrowing on anterior half, narrowing again to apodemal apex, shaft slender. Connective Y-shaped; shaft broad, slightly narrowing toward deeply bifid apex, lateral apices appearing bifid, shaft length about three times arm length.

Types: Holotype male, Fern Cliff, Ill., Aug. 3, 1934, DeLong and Mohr, deposited in collection of Dr. D. M. DeLong. Type studied.

Material studied: Only type material.

Notes: Quite rare.

43. *Texananus (Iowanus) caducus* DeLong

Texananus caducus DeLong, Ohio Jour. Sci., vol. 39, 1938, p. 238.

Resembling *dicentrus* in body form and coloration but connective ventral shaft in lateral view stout, curving posteriorly on proximal two thirds, then posteroventrally directed on apical one third, which slightly curves ventrally in a long beak to a point, apical third cleft in dorsal view; female seventh sternum with posterior lateral angles acutely produced and a pair of produced median teeth separated by a wide V-shaped notch.

Genitalia: Female seventh sternum three eighths as long as wide, lateral margins strongly converging from base, posterior lateral angles slightly acutely produced, a pair of produced teeth on middle of slightly concave posterior margin, separated by a wide large V-shaped notch, with width two-fifths distance to base. Male in lateral view: Pygofer somewhat trapezoidal in shape, upper margin about third length of lower, posteriorly narrowed to a thick tapering lobe, tapering hook arising below base of lobe curves inward and posteriorly. Aedeagal base nearly horizontal, its length almost two thirds aedeagal length, preatrium short; aedeagal shaft with basal depth of one sixth base length, posteroventrally directed from anterior base portion, tapering as it curves posteriorly and upward in a long slender straight apical two thirds. Connective shaft deepest

at articulation, is directed ventrally, then curves posteriorly as a long stout shaft, terminating in an abrupt down turn of a long ventral beak, its length one third shaft length. In dorsal view: Aedeagus widest basally, horizontal base area narrowing posteriorly, aedeagal shaft slender its entire length, with bifid apex. Connective Y-shaped with arms separated basally and parallel; shaft wide basally, gradually tapering to deeply cleft apex.

Types: Holotype male, allotype female, Ada, Oklahoma, July 16, 1937, Standish and Kaiser. Male and female paratypes, Lebanon, Oklahoma, Hinton, Oklahoma, and Grant, Oklahoma, July, 1937; Clarksville, Tennessee, August, 1917, DeLong; High Knob, Ill., October, 1934; Anvil Rock, October, 1934; Havana, Ill., Nov., 1912, and Aug., 1934; and Fern Cliff, Ill., August, 1934, Frison, Ross, Mohr and DeLong. Types in collection of Dr. D. M. DeLong. Paratypes in the Illinois Natural History Survey Collection and the Oklahoma A. and M. College Entomological Collections. Types studied.

Material studied: (Georgia) Prattsburg, July 25; (Tennessee) Clarksville, Aug. 14; (Kentucky) Cadiz, June 30; (Mississippi) Fulton, July 14, Columbus, Leland; (Missouri) Jefferson City, Aug. 3; (Arkansas) Scott County; (Louisiana) Covington, June 23; (Kansas) Douglas Co., Aug. 5, Onaga; (Texas) Cisco, June 19, Palopinto Co., July 14.

Notes: Range, in south central states and eastward to Georgia.

44. *Texananus* (*Iowanus*) *bullatus* DeLong

Texananus bullatus DeLong, Ohio Jour. Sci., vol. 39, 1939, p. 237.

Resembling *longipennis* in body form, coloration, and form of male pygofer but connective ventral shaft in lateral view with short, ventrally curved beaklike apex, cleft in dorsal view; female seventh sternum with strongly produced posterior lateral angles much beyond paired median teeth separated by a narrow notch halfway to base.

Genitalia: Female seventh sternum about half as long as wide, lateral margins converging from base, posterior lateral angles strongly and acutely produced at lateral margins, posterior margin concave between lateral angles with pair of blunt teeth on middle third separated by a deep slender notch, notch depth half sternum length medially. Male in lateral view: Pygofer rather rectangular, greatest depth about seven-twelfths length, neglecting posterior lobe; a rounded posterior lobe constricted basally at upper posterior corner and a hook arising near base of lobe curves inwardly and posteriorly downward. Aedeagal base, inclined dorsoposteriorly,

length about two thirds aedeagal length, preatrium long and slender, apodemal process roundly expanded winglike above; aedeagal shaft with basal width of one seventh base length, posteriorly directed on proximal third, then curving dorsad, tapering to slender apex near pygofer hook. Connective shaft stout, deepest at aedeagal articulation, curving posteroventrally on proximal fifth, then posteriorly directed to a cleft apex turned ventrally in short beaks. In dorsal view: Aedeagus widest basally, slightly narrowing along slender shaft, with sharpened apex; posterior apodemal portion roundly inflated. Connective Y-shaped, with arms widened on inner margins at middle and sinuously converging apically; shaft stout, about twice arm length.

Types: Holotype male and allotype female, Jemez Springs, New Mexico, June 15, 1919, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Arizona) Mt. Lemmon, Oak Creek Canyon, Atascosa Mts., Oct. 24.

Notes: Range, New Mexico and Arizona.

45. *Texananus* (*Iowanus*) *longipennis* sp. nov.

Resembling *Texananus* (*Iowanus*) *majestus* (Osborn and Ball) in form and coloration but slightly smaller, crown slightly narrower, posterior corners of narrow median notch of female seventh sternum not strongly produced, the ventrally directed apical cleft portion of the connective ventral shaft short. Length 8.5 mm.

Structure: Crown convex, rather narrow, length at middle about one-fourth longer than next to eye and about twice width at anterior edge of eyes, rounded with front. Clypeus slender, wedge-shaped, about three-sevenths longer than width at base. Clypellus narrowed at base, gradually widening to apex. Pronotum broad, much wider posteriorly, anteriorly pushed forward between eyes. Elytra long, about four times the combined length of head and pronotum, appendix well developed.

Color: Pronotum yellowish with a transverse band between eyes, band broadest at middle and bifid near eyes, pair of spots near apex of crown. Clypeus brownish with distinct lateral horizontal arcs. Clypellus with larger pair of brown spots at base and a pair of small dark spots at middle. Pronotum regularly blotched with brown on anterior third and with brown irrorations on posterior two thirds. Scutellum brownish with a pair of ivory spots on lateral margins. Elytra evenly marked with brown vermiculate lines, without distinct costal spots.

Genitalia: Female seventh sternum slightly more than one third as long as wide, lateral margins almost parallel, posterior lateral angles slightly and roundly produced about even with the obtuse produced middle third, with a slender median notch extending halfway to base, forming a tooth on either side. Male valve triangular, median length slightly more than half width, apex broadly rounded, almost truncate. Plates roundly broadest on basal third, then tapering to a rather acutely rounded apex. Male in lateral view: Pygofer somewhat trapezoidal, upper margin only half as long as lower; a long ovate lobe at upper posterior corner and a long curved hook arising from base of lobe, curving inward and posteriorly to a sharp point. Aedeagal base almost horizontal, its length about three fifths length of aedeagus, concave with lower third curving anteriorly along the preatrium to articulation; aedegal shaft with basal depth of about one sixth base length posteroventrally directed on basal fifth, then rapidly curving dorsoposteriorly as a rather straight shaft to apex. Connective ventral shaft extremely broad at articulation, posteriorly and ventrally directed, rapidly reducing to a stout shaft which curves posteriorly to a cleft ventrally directed apical fifth. In dorsal view: Aedeagus widest at articulation, narrowing slightly on basal two thirds of base, then tapering posteriorly to apodeme portion; shaft slender to apex. Connective somewhat Y-shaped, with arms rather widely separated and parallel; shaft broad to cleft apex.

Types: Holotype male, allotype female and nine male paratypes, Tuskegee, Alabama, July 22, 1930, L. D. Tuthill. Other paratypes: two males, Clarksville, Tennessee, Sept. 9, 1915, R. H. Beamer; four males and one female, Clarksville, Tennessee, July 28, 1915, R. H. Beamer; one male and one female, Greene Co., Tennessee, Sept. 30, 1948, M. Wright; two males, East River, Connecticut, 1910, C. R. Ely; one male, County 88, Iowa, October 17, 1935, H. E. Jaques. Holotype, allotype, and paratypes deposited in Snow Entomological Collections, University of Kansas; paratypes in Ohio State University Entomological Collections; paratypes in U. S. National Museum.

Material studied: (Georgia) Prattsburg, Aug. 25; (Tennessee) Magnolia, Sept. 21; (Mississippi) Leland, Sept. 16; (Arkansas) Polk County, July 21.

Notes: Range, in the southeastern states. This form is found in relative abundance.

Synopsis of the Genus PARAPHLEPSIUS Baker

Paraphlepsius Baker, Canad. Ent., vol. 29, 1897, p. 158. Type by original designation. *Paraphlepsius ramosus* Baker 1897, but *P. ramosus* Baker is synonym of *Paraphlepsius humidus* (Van Duzee) 1892, which is therefore, the type of the genus *Paraphlepsius*. *Phlepsius* subgenus *Pendarus* Ball, Canad. Ent., vol. 59, 1927, p. 262. Type by original designation, *Phlepsius slossonae* Ball, 1905.

Originally described as follows:

"*Paraphlepsius*, n. gen.—Head about the same width as the prothorax and considerably shorter, three and a half times as broad as long, anteriorly foliaceous, angulate, vertex level. Face of the normal Jassid type. Frontal sutures continued to the edge of vertex. Ocelli on the edge between vertex and face, somewhat removed from the tip, with a narrow appendix. Apical cells four, anteapical two, basal transverse vein entering radial cell or clavus with two longitudinal veins. Wings with three apical cells exclusive of the closed costal.

"This genus is nearest to *Psegmatus*, Fieber, from which it differs in having the head broader and much shorter than pronotum, and the frontal sutures nearly straight, instead of strongly bent inward, as in *Psegmatus*. Type:—*Paraphlepsius ramosus* n. sp."

Crown often concave; face broad, clypeus broad basally; male plates of various shapes, spinelike setae uniserate; connective Y-shaped; aedeagus variously modified, sometimes slightly asymmetrical; gonopore terminal, sinistral or dextral; pygofer setose, usually produced into one or more short spines.

KEY TO THE SPECIES OF PARAPHLEPSIUS BAKER

1.	In ventral view genital capsule with pygofers widely separated by valve and plates (males)	2
	In ventral view genital capsule with pygofers closely appressed to slender ovipositors (females)	66
2.(1)	Aedeagal shaft extremely long with four slender spines on apical half	46. *nudus*
	Aedeagal shaft variable but not as above	3
3.(2)	Aedeagus with long pair of pronglike processes arising at base and extending posteriorly nearly paralleling aedeagal shaft to beyond middle of shaft, often to near shaft apex	4
	Without long pronglike processes extending beyond middle of shaft	18
4.(3)	Aedeagal shaft much shorter than processes, recurved ventrally at apex, shaft apex bifid in dorsal view	5
	Aedeagal shaft as long or nearly as long as pronglike processes	6
5.(4)	Pronglike processes of aedeagus in lateral view curved dorsoposteriorly on proximal third, then posteriorly to apices	47. *cinereus*

Pronglike processes of aedeagus directed posteriorly on proximal half then arching dorsally on apical half, 48. *truncatus*

6.(4) Ventral posterior margin of pygofer in lateral view rounded without beak 7

Ventral posterior margin of pygofer in lateral view with a beak or hook, sometimes inside margin 8

7.(6) Processes of aedeagus bifid at apex ..... 49. *texanus*

Processes of aedeagus tapering to a point ..... 50. *electus*

8.(6) Dorsal posterior corner of pygofer in lateral view rounded, without beak 9

Upper and lower posterior margins of pygofer with beaks or large pygofer hook from upper margin 11

9.(8) Aedeagal shaft sickle-shaped, with apex curved ventrad, processes shorter than shaft posteriorly ..... 51. *planus*

Aedeagal shaft not sickle-shaped, processes at least as long as shaft 10

10.(9) Apex of aedeagus truncate in lateral view with pair of ventrally directed spinelike processes on apical third of ventral margin ..... 52. *cornutus*

Apex of aedeagus not truncate with its processes arising from base, closely appressed to shaft ..... 53. *floridanus*

11.(8) Apical third of aedeagus in lateral view as a ventrally recurved portion ..... 54. *lascivius*

Apical third not ventrally recurved in lateral view 12

12.(11) Apex of aedeagus in lateral view as a dorsally directed foot ..... 55. *bipartitus*

Apex of aedeagus with a ventral beak in lateral view 13

13.(12) Aedeagal shaft in lateral view with a dorsal tubelike projection just beyond the middle ..... 56. *tubus*

Aedeagal shaft without dorsal projection near its middle .. 14

14.(13) Apex of aedeagal shaft in lateral view with a slender pair of ventral beaks, their length almost twice shaft width at middle ..... 57. *lobatus*

Aedeagal apex in lateral view with apical beaks shorter than width at middle 15

15.(14) Ventral posterior marginal beak of pygofer much anterior to dorsal beak ..... 58. *torridus*

Ventral marginal posterior beak of pygofer located about vertically below upper beak or slightly posterior 16

16.(15) Apex of aedeagal shaft in lateral view projected dorsally about as far as sharp apical processes extend ventrally, 59. *umbrosus*

Apex of aedeagal shaft not projected dorsally from shaft opposite a ventral beak 17

17.(16) Dorsal pygofer hook on dorsal margin half as long as pygofer ..... 60. *collitus*

Dorsal pygofer hook much less than pygofer length, 61. *attractus*

18.(3) Aedeagal shaft in lateral view curved ventrally on apical portion usually tapering from base as a sickle-shaped structure 19
Aedeagal shaft not as above, variable 25
19.(18) Pygofers with posteriorly directed hooks from upper margin 20
Hooks if present not posteriorly directed 21
20.(19) Pygofer hook long, about half pygofer length and processes on base ..... 62. *solidaginis*
Pygofer hook much shorter, not more than a fourth pygofer length ..... 63. *humidus*
21.(19) With short lateral slender accessory processes arising near ventral side of aedeagal shaft base and extending posteriorly ..... 64. *carolinus*
Without lateral slender accessory processes 22
22.(21) With dorsally directed beak on upper margin, aedeagal shaft extremely long and slender ..... 65. *optatus*
With dorsally directed long pygofer hooks, aedeagal shaft not extremely slender 23
23.(22) With long dorsoposteriorly directed hook from lower posterior corner of pygofer ..... 66. *pusillus*
With rounded lower posterior corner, hooks at upper posterior corner 24
24.(23) Preatrium extremely long and curving in lateral view. Aedeagal shaft about length of pygofer ..... 67. *occidentalis*
Aedeagal basal portion quadrate in lateral view. Aedeagal shaft less than pygofer length ..... 68. *eburneolus*
25.(18) Posterior margin of pygofer with one dorsally directed or mesally directed slender sharpened hook 26
Posterior margin of pygofer without a dorsally directed hook 36
26.(25) Plate with apical inner margin turned upward into a spatulate apex in lateral view 27
Plate with inner apical margin not turned upward 31
27.(26) Aedeagus with retrorse subapical teeth in dorsal view 28
Without retrorse subapical teeth in lateral view 30
28.(27) Aedeagal shaft apex sagittate in dorsal view, sharpened at tip ..... 69. *apertinus*
Aedeagal shaft with rounded apex with retrorse subapical teeth 29
29.(28) Aedeagal shaft width anterior to toothed apical portion less than apical width ..... 70. *excavatus*
Aedeagal shaft apical half swollen, wider than toothed apical portion ..... 71. *acutus*
30.(27) Aedeagal shaft apical portion rather quadrate with a posteriorly directed long beak in lateral view ..... 72. *apertus*
Aedeagal shaft apical portion not quadrate in lateral view ..... 73. *irroratus*

31.(26) Aedeagal shaft with a slender median dorsal process on middle of shaft ..... 74. *altus*
Shaft without median dorsal process 32
32.(31) Aedeagal shaft in lateral view lobelike with a short bifid ventral process at middle ..... 75. *fulvidorsum*
Not as above, aedeagal shaft apex with small ventral beak or dorsally directed and cleft 33
33.(32) Apex of aedeagus in dorsal view, with pair long stout posterolateral horns ..... 76. *tennessa*
Apex of aedeagus not as above 34
34.(33) Aedeagus simple in lateral view without processes or prominent apodemes ..... 77. *macullelus*
Aedeagus with processes or prominent apodemes 35
35.(34) Aedeagus with pair of ventral accessory spines arising on apical half ..... 78. *certus*
Aedeagus without pair accessory spines on apical half. 79. *dentatus*
36.(25) Aedeagal shaft posteriorly directed, tapering as it curves dorsally with pair of apical processes recurved 37
Aedeagus not as above 44
37.(36) With beak or hooks at posterior margin of pygofer 38
Without beaks or hooks on pygofer 43
38.(37) Pygofer with a ventral and dorsal hook at posterior margin, 80. *hemicolor*
Pygofer with only one posterior hook or beak ventrally directed 39
39.(38) Aedeagal shaft with a pair of dorsally directed subapical spinelike processes ..... 81. *tigrinus*
Aedeagal shaft without subapical processes 40
40.(39) Aedeagal shaft with slender pair of processes arising at the aedeagal right angle bend and closely paralleling apical half to apex ..... 82. *rossi*
Aedeagal shaft without processes proximal to apical processes 41
41.(40) Aedeagal shaft at apex symmetrical ..... 83. *palustris*
Aedeagal shaft at apex asymmetrical 42
42.(41) Upper posterior corner of pygofer acutely angular, 84. *lippulus*
Apex of posterior margin of pygofer rounded, corner about right angle ..... 85. *strobi*
43.(37) With subapical dorsally directed spines arising at lower margin of aedeagal shaft ..... 86. *spinosus*
Without subapical dorsal spines. Apodemes in lateral view curved ..... 87. *supinus*
44.(36) Aedeagal shaft sickle-shaped, tapering as it curves dorsad and anteriorly to sharpened apex, usually asymmetrical, 45
Aedeagal shaft not sickle-shaped as above 48
45.(44) Pygofer with three teeth on posterior margin 47
Pygofer with less than three teeth on posterior margin 46

46.(45) Pygofer with avicephaliform projection on the posterior margin ..... 88. *avicephalus*
Pygofer with two projections, one of which is avicephaliform ..... 89. *punctiscriptus*
47.(45) Lower notch of posterior margin of pygofer much wider than base of middle tooth ..... 90. *slossonae*
Lower notch of posterior margin of pygofer about as wide as base of middle tooth ..... 91. *tullahoma*
48.(44) Aedeagal shaft with apical half ovate in lateral view and keeled dorsally. At least one pygofer hook near middle of dorsal margin 49
Aedeagal shaft of various shapes but not as above, without hooks on dorsal marginal middle of pygofer 53
49.(48) Posterior margin of pygofer rounded, not truncate. Pygofer hook within capsule large, curving strongly ventrad posteriorly and back dorsally 50
Posterior margin of pygofer truncate, corners usually roundly projected 51
50.(49) Apices of plates truncate with mesally directed teeth on middle of apex ..... 92. *obvius*
Apices of plates without teeth ..... 93. *emarginatus*
51.(49) Posterior margin of pygofer sloping somewhat dorsoposteriorly, angle of lower corner slightly obtuse, hook at dorsal margin directed inward ..... 94. *maculosus*
Posterior margin of pygofer about vertical, paralleling anterior margin, corners roundly produced. Median hook not directed inward 52
52.(51) Length of posterior margin of pygofer only about half greatest width of pygofer. Marginal hook posteriorly directed ..... 95. *pallidus*
Length of posterior margin of pygofer greater than half greatest width of pygofer. Marginal hook strongly curved mesad and then posteriorly ..... 96. *divergens*
53.(48) Posterior corners of pygofer with dorsal and ventral hooks or long beaks 54
With only one hook at posterior border of pygofer directed caudally or ventrally, or if hooks or beak not prominent, aedeagus of odd shape 56
54.(53) Aedeagal shaft in lateral view short, sides parallel, with small tooth on middle of posterior margin of pygofer, 97. *operculatus*
Aedeagal shaft not shaped as above, without tooth on posterior margin of pygofer 55
55.(54) Plates laterally constricted or notched on outside margin on apical half, their apices roundly truncate ..... 98. *mimus*
Plates not laterally notched as above ..... 99. *bifidus*
56.(53) Aedeagal shaft as a quadrate structure in lateral view, with a hook arising on posterior portion of dorsal margin of pygofer 57

Aedeagal shaft not quadrate, pygofer hook arising at posterior margin 62

57.(56) Pygofer hook sinuous, arising from upper posterior margin, extending posteriorly ..... 100. *turpiculus*

Pygofer hook turned ventrally over posterior margin 58

58.(57) Pygofer hook rather abruptly bent over posterior margin but apex scarcely reaching beyond lower margin, hook short 59

Pygofer hook rather long, arising on upper posterior marginal third and roundly curving ventrally past ventral margin of pygofer 60

59.(58) Pygofer hook abruptly bent ventrad to about even with lower margin of pygofer ..... 101. *abruptus*

Pygofer hook bent obtusely ventrad only slightly beyond lower margin, apex of hook curved slightly posteriorly, 102. *continuus*

60.(58) Pygofer hook rather long, slender, following the rounded posterior margin to well below ventral margin 61

Pygofer hook extremely long, curving rather abruptly ventrad anterior to pygofer apex and ending considerably beyond lower margin ..... 103. *siclus*

61.(60) Pygofer hook angularly bent ventrad ..... 104. *fuscipennis*

Pygofer hook almost straight, directed posteroventrally, 105. *fuscipennis* var. *seminolus*

62.(56) With pygofer hook caudally directed 63

With pygofer hook ventrally directed 64

63.(62) Aedeagal shaft long with margins appearing undulated in lateral view. Plate length over two times valve length, 106. *rileyi*

Aedeagal shaft straight. Plate length only about twice valve length ..... 107. *incisus*

64.(62) Aedeagus horseshoe-shaped in lateral view, connective articulation at middle of curve ..... 108. *brunneus*

Aedeagus not horseshoe shaped 65

65.(64) Apex of aedeagus in dorsal view flaring without processes, 109. *latifrons*

Aedeagal shaft not as above, with subapical flaplike teeth as processes ..... 110. *particolor*

66.(1) Seventh sternum posterior margin broadly excavated at least one third distance to base 67

Seventh sternum if excavated, only shallowly, less than one-third distance to base, not including median slit 76

67.(66) Excavation of seventh sternum rather parallel-sided with posterior corners angulate 68

Excavation of seventh sternum V-shaped or slightly rounded at bottom 72

68.(67) Excavation with a large median tooth at bottom between acute posterior angles of excavation ..... 73. *irroratus*

Excavation to base, or at least three fourths way to base, 69

69.(68) Excavation reaching base of seventh sternum 70
Excavation at least three fourths to base with a square cornered truncate bottom 71

70.(69) Width of bottom of excavation of seventh sternum about equal to basal width of lateral piece..... 70. *excavatus*
Width of bottom of excavation of seventh sternum roundly wider than basal width of lateral piece..... 69. *apertinus*

71.(69) Posterior corners of excavation of seventh sternum rounded and not extending posterior to lateral angles .. 72. *apertus*
Posterior corners of excavation in seventh sternum acute, about even with or posterior to lateral angles.. 71. *acutus*

72.(67) Excavation of seventh sternum extending from acute lateral angles to a pointed bottom..... 73
Lateral angles not pointed 74

73.(72) Length of sternum about three fourths width, lateral angles black at apices and curled under in ventral view, 109. *latifrons*
Length of sternum about four fifths width, lateral angles sharp but only turned down ..... 97. *operculatus*

74.(72) Excavation of seventh sternum with depth of about two thirds sternum length, lateral angles rounded... 99. *bifidus*
Excavation of seventh sternum scarcely half as deep as length of sternum 75

75.(74) Posterior corners of excavation of seventh sternum roundly produced ..... 56. *tubus*
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46. *Paraphlepsius nudus* (Ball)

Phlepsius nudus Ball, Canadian Ent., vol. 43, 1911, p. 204.

Resembling *occidentalis* in body form and coloration but shorter and crown strongly depressed; aedeagal shaft extremely long and slender, slightly tapering, apex bifid, four sharp spines arising in apparent irregularity along apical portion; female seventh sternum roundly truncate between produced lateral angles and with a small median notch.

Genitalia: Female seventh sternum about three-fifths as long as wide, their posterior third to the slightly produced posterior lateral angles, posterior margin truncate with a small median notch. Male in lateral view: Pygofer somewhat rectangular, its width uniformly reduced posteriorly, a short blunt point on posterior margin above lower posterior corner, greatest width of pygofer about three fifths its length. Aedeagal base nearly horizontal from articulation, its length about half aedeagal length; aedeagal shaft anteroventrally directed, gradually widening to below articulation, then diminishing in size immediately into a long slender portion which extends ventrad, then dorsoposteriorly in a large curvature, terminating in a bifid apex beyond upper posterior corner of pygofer; four sharp slender spines arise on apical half of shaft with apparent irregularity. In dorsal view: Aedeagal base about four times wider than reduced shaft width, its posterior apodemal apex deeply bifid. Connective Y-shaped with arms abruptly converging subapically, then turned outward apically; shaft wide, its sides almost paralleling the arms and its length about equal to arm length.

Types: Lectotype male (wing apices missing), Seven Oaks, Flor-

ida, May 1, 1908, Van Duzee, here designated and syntype female, Fort Myers, Florida, Van Duzee, in collection of E. D. Ball, deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (North Carolina) Shallotte; (Georgia) Okefenokee Swamp, July 25, Adel, Aug. 11, Millwood; (Florida) Lake City, Hilliard, New Smyrna, Branford, Aug. 4, Old Town, DeLand, Yankeetown, July 31, Sebastian, Zolfa Spring, Sanford, Tampa, Palm Beach, Naples, Picnic.

Notes: Range, in Florida and the Southeast. Occurs on small grasses of floor of pine woods according to DeLong (1926).

47. *Paraphlepsius cinereus* (Van Duzee)

Phlepsius cinereus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 68.

Resembling *truncatus* in body form and coloration but color markings more sparse and cinereus; aedeagal basal paired processes curving dorsoposteriorly on their proximal third, then directed caudally and tapering to a sharp apex beyond pygofer; female seventh sternum with its median paired lobes produced slightly beyond the rounded produced posterior lateral angles.

Genitalia: Female seventh sternum about half as long as wide, lateral angles scarcely produced, a moderately produced lobe with a small V-shaped notch on middle of posterior margin. Male in lateral view: Pygofer nearly triangular, upper and lower margins about the same length, its greatest width about seven ninths length. Aedeagal base slightly inclined anteriorly from the vertical, its length about equal to aedeagal length, the long processes not included; aedeagal shaft short, posteriorly directed from upper base to a sharp apex at upper margin and with a subapical recurved beak below; a stout pair of prongs, posteriorly directed from base, reduced rather rapidly at base from a basal width equal to base length to slender processes curving upward on their proximal third then curving posteriorly, tapering to their sharp apices beyond plate apices. In dorsal ivew: Aedeagus sharply bifid anteriorly and posteriorly along dorsal portion, the base below much wider; lateral apodemal horns prominent; the pronglike processes sinuously parallel to their apices.

Types: Lectotype male Aaron, Texas, Herbert Osborn, designated by P. W. Oman (1946) in Iowa State College Entomological Collections and one syntype female in same collection; a topotype female, Aaron, Texas, in Ohio State University Entomological Collections. Types studied.

Material studied: (Ohio) Crown City; (Iowa) Ames; (Kansas) Bourbon County, Oct. 12, Clay County, Wellington, Douglas County, June 8; (Texas) College Station, June 23, Brownsville.

Notes: Range, throughout in the central states. Found in upland pasture on *Andropogon virginicus* (DeLong 1946).

48. *Paraphlepsius truncatus* (Van Duzee)

Phlepsius truncatus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 72.

Resembling *cinereus* in body form and coloration but body slightly shorter and coloration darker; aedeagal basal paired processes directed posteriorly on proximal half, then arching and tapering on distal half to apex beyond pygofer; female seventh sternum with posterior margin slightly rounded with a very shallow excavated truncate margin on middle third.

Genitalia: Female seventh sternum about two thirds as long as wide, lateral margins almost parallel, posterior lateral angles not produced, posterior margin slightly rounded with a very shallow excavated truncate margin on middle third. Male in lateral view: Pygofer somewhat triangular, upper posterior corner bluntly acute, ventral margin shorter than dorsal, a short beak at lower posterior corner, greatest depth of pygofer about five eighths its length. Aedeagal base nearly upright, its shortest length about one sixth aedeagal length, deeply concave with lower marginal half curving anteriorly along the preatrium to articulation; aedeagal shaft proper short, posteriorly directed from upper base to apex with a ventrally recurved beak; a pair of stout tapering pronglike processes arise from the upper base, their proximal half about horizontal, their distal half arched upward and terminating slightly beyond plate apices. In dorsal view: Aedeagus with sharp V-shaped cleft at its posterior and anterior ends; lateral apodemes prominent from broad basal portion; pronglike processes diverging from base. Connective Y-shaped; shaft broad, its length about equal to arm length.

Types: Lectotype female, Balsam, N. C., July 23, 1890, W. J. Palmer, designated by P. W. Oman (1946) in Iowa State College Entomological Collections. Type studied.

Material studied: (Florida) Leon County, April 24; (Ohio) Delaware Co., Columbus; (Texas) Gillespie Co., Cedar Val.; (Tennessee) Clarksville, June 25, July 4, Aug. 31, Oct. 30, Magnolia, Wanesboro, Aug. 4; (Kansas) Douglas Co., June 21, July 10, Cherokee Co., Coffeyville, Medora, Galena, Oct., Greenwood County; (Arkansas) Fayetteville, Polk Co., July 21; (Mississippi) Fulton, July 14; (Missouri) Atherton, June 18.

Notes: DeLong (1926) states that it is a meadow species of the northern states.

49. *Paraphlepsius texanus* (Baker)

Phlepsius texanus Baker, Canadian Ent., vol. 30, 1898, p. 31.

Resembling *punctiscriptis* externally in body form and coloration but male slightly larger than *punctiscriptis* male and color more cinereus with brownish irrorations more distinct; aedeagal shaft arching upward and tapering from base to apex as it curves ventrally hooklike; slender pair of lateral processes from base of aedeagus posteriorly directed and terminating in a two-tined apical fourth; female seventh sternum with a moderately wide truncate posterior margin between roundly produced posterior lateral angles.

Genitalia: Female seventh sternum about seven twelfths as long as wide, lateral margins posteriorly converging from base, posterior lateral angles produced on either side of a truncate posterior margin. Male in lateral view: Pygofer triangular in shape, upper margin sloping posteriorly downward, posterior marginal apex rounding. Aedeagal base nearly upright, its lower margin forming a deep ventrally directed concavity, base shortest length about one fourth aedeagal length, lower margin of basal concavity curves anteriorly and dorsad along an extended preatrium to articulation; preatrium continuous posteriorly with a posterior projection half base length, and dorsad to shaft proper; aedeagal shaft, dorsoposteriorly directed proximally, gradually tapering from a basal depth of one-fourth aedeagal length of apex, distal portion curving ventrally to a slender apex; a pair of slender processes, about aedeagal length, arise from expanded lateral apodemes and terminate in a two-tined apical fourth. In dorsal view: Aedeagus with base portion wider than stout tapering shaft; laterally expanded apodemes prominent; aedeagal processes diverging in their middle but converging apically. Connective Y-shaped, its shaft very short and broad.

Types: Lectotype female, Texas, C. V. Riley here designated, and syntypes in collection of C. F. Baker deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: Specimen of the C. V. Riley Collection; (Mississippi) Okolona, June 28.

Notes: Range, in Texas and eastward.

50. *Paraphlepsius electus* (DeLong)

Phlepsius electus DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 44.

Resembling *irroratus* in body form and coloration but brownish irrorations paler and markings sparse on elytra; aedeagal shaft in lateral view wide at base, dorsoposteriorly directed and tapering to an apical avicephaliform apex; a pair of straight prongs arising at dorsal aedeagal base and paralleling aedeagal shaft dorsal to shaft to slightly beyond its apex.

Genitalia: Female not known. In lateral view: Pygofer somewhat rectangular, but dorsal and ventral margins converging posteriorly, a small dorsal beak at upper posterior corner and lower posterior corner rounded, greatest width of pygofer about three fifths its length. Aedeagal base about upright, its length slightly more than one third aedeagal length, preatrium short; aedeagal shaft with basal width about one-third base length, dorsoposteriorly directed, slightly tapering to an enlarged avicephaliform apex; a pair of pronglike processes arise from near apodemal base portion and are directed posteriorly to slightly beyond aedeagal apex. In dorsal view: Aedeagus wide at base and roundly swollen on apical third; pronglike processes diverging on their apical fourth. Connective Y-shaped with arms converging on their apical half; shaft broad, its length about half arm length.

Types: Two male cotypes, Shannon Co., Missouri, Sept. 8, 1930, and Apple River Canyon State Park, Illinois, deposited in collection of Dr. D. M. DeLong and Illinois Natural History Survey Collection. Types studied.

Material studied: Only type material.

Notes: Range, Missouri and Illinois. This form is similar to *P. torridus*.

51. *Paraphlepsius planus* (Sanders and DeLong)

Phlepsius planus Sanders and DeLong, Proc. Ent. Soc. Wash., vol. 24, 1922, p. 98.

Resembling *solidaginis* in body form and coloration but with short depressed crown, markings of elytra very sparse but regular in pattern; aedeagal shaft in lateral view as an arched stout "sickle" shaped structure with lateral short slender processes from aedeagal base closely appressed to aedeagus; pygofer in lateral view generally rectangular with only small beak at lower posterior corner; female seventh sternum smaller with posterior lateral angles strongly produced and turned medially toward a pair of median lobes moderately produced.

Genitalia: Female seventh sternum about three fourths as long as wide, lateral margins abruptly converging on posterior third, posterior lateral angles strongly produced into slender lobes, posterior margin with median obtuse lobe strongly notched. Male in lateral view: Pygofer, generally rectangular, dorsal margin rounded above and sloping downward posteriorly with a short beak at lower posterior corner, greatest width of pygofer about three fourths its length. Aedeagal base dorsoposteriorly inclined, its shortest length about one fourth aedeagal length, concave with its lower half curving anteriorly and upward along the preatrium to articulation; preatrium continuous posteriorly with a dorsally directed expanding "sickle handle" of the upper shaft portion; aedeagal shaft stout, curving posteriorly and ventrally, apical third tapered; a pair of parallel processes arise basally on sicklelike portion, following its lower margin to near the diminished apex of aedeagus. In dorsal view: Aedeagal basal third much wider than tapering apical portion; blunt lateral apodemes prominent; shaft, processes slender and slightly diverging. Connective Y-shaped with arms stout, their apices converging anteriorly; shaft slender, length about two fifths arm length.

Types: Twenty-two cotypes, Paradise Key, Apr. 5-10, 1921, D. M. DeLong, deposited in collection of Dr. D. M. DeLong; one cotype, Feb. 19, 1919, Schwarz and Barber, deposited in U. S. National Museum Collection; one cotype, Cleveland, Fla., Apr. 25, 1921, J. N. Knull.

Material studied: (Georgia) Okefenokee Swamp; (Florida) Plant City, Lake Jovita, Hobe Sound, July 21, Bradenton, Parish, July 9, Lacoohee, Lake Placid, July 13, Deerfield, Aug. 26, Bell Glade, Edgewater, Royal Palm Park, Gainesville, Sanford, Sarasota County, Cocoanut Grove, Aug. 9, Paradise Key, April 9, Leon County, Tampa, Homestead, July 19, Dade County, Fruitville, Aug. 11, Hudson, Sannibal, Dunnellon, Ochopee, Morrison Field, Sept. 12, Lake County, June 22.

Notes: Range, in Florida and Georgia swamps. Abundant on maiden cane *Panicum hemitomum* in Florida everglades (DeLong 1926).

52. *Phlepsius cornutus* sp. nov.

Resembling *Paraphlepsius attractus* (Ball) in general form and color, but slightly smaller aedeagal apical half bearing a pair of posteroventrally directed horns and with dorsal aedeagal processes more strongly curved, posterior lateral angles scarcely produced

and middle of posterior margin of female seventh sternum only moderately produced as two indicated lobes. Length, 5 mm.

Structure: Crown one third longer at middle than next to eye, disc nearly flat, with a slight transverse depression near posterior border, bluntly rounded with front, apex rather roundly conical. Clypeus slightly tumid. Clypellus constricted subbasally, gradually widening to apex. Pronotum rather long, set forward mesally into crown, slightly rugose across middle. Elytra flaring slightly at the middle of the costal margin.

Color: Dorsum irregularly inscribed with tawny brown irrorations, darker and denser on female. Crown irregularly marked with pair of irregular dark brown areas near base, a medial and two lateral yellow areas on margin, ocelli encircled with yellow. Face finely and densely irrorate with tawny. Clypeus with two lateral ivory spots on a line between eyes with two outer light spots next to eyes, with indications of light arcs below. Pronotum mottled with brown. Scutellum soiled yellow with three posterior ivory spots margined with dark brown. Elytra milky, rather evenly vermiculate with brown, coloration much less dense in male, several distinct costal spots, indications of light transverse broad bands across clavus.

Genitalia: Female seventh sternum about two thirds as long as wide, lateral margins sinuously parallel, posterior lateral angles slightly produced, middle half of posterior margin produced obtusely with a slight median notch. Male valve triangular, broad, apex sharply obtuse. Plates broadest on basal third converging laterally to rounded apices. Male in lateral view: Pygofer somewhat rectangular, posterior half slightly turned ventrad with a short beak at lower posterior corner, greatest width of pygofer anteriorly almost two thirds length. Aedeagal base nearly upright, length one-fourth aedeagal length, preatrium short; aedeagal shaft with basal width one fourth greater than base length, posteroventrally directed, diminishing to half basal width as it curves gradually dorsad to a truncate apex with a small ventral beak, the apical half bearing a pair of posteroventrally directed tapering horns; a pair of prong processes arise at upper base border and follows contour of proximal two thirds of aedeagus, then curve dorsally to their apices. In dorsal view: Aedeagus broadest along proximal three fourths, narrowing apically, posterior horns closely parallel and tapering; dorsal processes separating at their middle.

Types: Holotype male, allotype female and two female paratypes, Homestead, Florida, April 14, 1947, Lucy D. Beamer. Other

paratypes: Two females, Big Pine Key, Florida, April 15, 1947, R. H. Beamer; two males and two females, Sanford, Florida, Aug. 25, 1926, E. D. Ball; one male, Lakeland, Florida, G. G. Ainslie. Holotype, allotype and paratypes deposited in Snow Entomological Collections, University of Kansas; paratypes in U. S. National Museum; paratypes in Ohio State University Entomological Collections.

Material studied: Only type material.

Notes: Range, in southern Florida. Females darker, with denser irrorations than males, much as in *P. attractus* variations.

53. *Paraphlepsius floridanus* (Ball)

Phlepsius floridanus Ball, Canadian Ent., vol. 41, 1909, p. 78.

Resembling *attractus* in body form and coloration but slightly smaller, vertex and crown more rounding and coloration slightly more uniform, about seven dark spots on margin of elytra; aedeagal shaft straight, dorsoposteriorly directed to roundly tapered apex; a pair of straight processes from base of aedeagus closely appressed along ventral border of shaft; female seventh sternum with less dark coloration along side of produced median lobes.

Genitalia: Female seventh sternum two thirds as long as wide, lateral margins roundly converging from base, posterior lateral angles produced, middle two fifths of posterior margin strongly produced with a shallow median notch. Male in lateral view: Pygofer somewhat rectangular, upper margin sloping downward on posterior half thus narrowing pygofer to the rounded posterior margin, short beak at lower posterior corner, greatest width of pygofer two thirds its length. Aedeagal base inclined dorsoposteriorly, its length half aedeagal length, slightly concave on lower half, preatrium short; aedeagal shaft with basal width of half base length, departs lower base half posteroventrally but immediately turns dorsoposteriorly as a straight shaft terminating in a blunt apex; paired processes arising at ventral base of shaft follow shaft closely appressed to apex. In dorsal view: Aedeagus basally broad and bulbous, narrowing to half its width at base of slightly tapering shaft, apex bifid. Connective Y-shaped with arms converging anteriorly; shaft, very broad and short, its length only one fifth arm length.

Types: Holotype female, Biscayne Bay, Fla., Annie Trumbull Slosson, in collection of E. D. Ball deposited in the U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (Georgia) Griffin, Aug. 11, Waycross, Hines-

ville; (Florida) Morrison Field, Nov. 2, Sanford, Eridu, July 11, Hilliard, Mar. 18, Oct. 5, LaBelle, Royal Palm Park; (Mississippi) Biloxi, Aug. 11.

Notes: Range, in Georgia and Florida. It appears externally similar to *P. attractus* and has been placed along with *P. graniticus* as a synonym under *P. attractus.*

54. *Paraphlepsius lascivius* (Ball)

Phlepsius lascivius Ball, Canadian Ent., vol. 32, 1900, p. 200.
Phlepsius micronotatus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 32.

Resembling *altus* in body form and coloration but larger and with paler coloration, margin of crown with pair of black areas at vertex distinctly seen from dorsal view; aedeagal shaft in lateral view curving upward on proximal two thirds, then curving ventrally to a flanged apex; pair of lateral slender processes from aedeagal base; female seventh sternum with posterior margin almost truncate between slightly produced lateral angles, median lobes small.

Genitalia: Female seventh sternum slightly more than half as long as wide, lateral margins rounding and converging abruptly on their posterior third, posterior lateral angles moderately produced, a median small lobe deeply notched on posterior margin. Male in lateral view: Pygofer somewhat rectangular, upper margin on posterior two thirds sloping down posteriorly to an anterodorsally projected stout spine, lower posterior corner cut away with ventral beak at lower anterior edge of slope, greatest width of pygofer about three fourths its length. Aedeagal base upright its length about one fifth aedeagal length, lower marginal third curving anteriorly along the preatrium to articulation; aedeagal shaft with basal width about equal to base length, posteriorly directed to its midpoint, then diminishing in size as it curves upward and abruptly ventrad terminating in a flanging apex near posterior margin of pygofer; a posteriorly directed pair of tapering pronglike processes arise at dorsal base border and terminate near base of pygofer spine. In dorsal view: Aedeagus widest at base, reduced on apical two thirds; pronglike processes separated on their middle; posterolateral apodemes prominent. Connective Y-shaped; shaft wide with a length about equal to arm length.

Types: Lectotype male, Fort Collins, Colo., July 5, 1898, here designated; syntypes, three males and eight females, Holly, Pueblo, and Fort Collins, Colorado, and Kimball, Nebraska. Types in col-

lection of E. D. Ball deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Minnesota) Battle Lake; (North Dakota) Dickinson, Medora; (Kansas) Scott Co., June 20, Hodgeman Co., July 17; (Montana) Hamilton, July 11; (Manitoba) Woodside, Aug. 9; (Wyoming) Laramie, July 13, Aug. 4; (Colorado) Creede, Aug., Akron, Ft. Collins, Rocky Ford, Grand Junction; (New Mexico) Cloudcroft, June 28, Tularosa, July 1, Stahmans, Ruidoso, Santa Cruz R.; (Nevada) Deeth, July 31; (Utah) Logan, Salt Lake, Richfield, Salina; (Idaho) Nampa, July 8; (Arizona) Santa Cruz R., Huachuca Mts., Benson, Phoenix, Granite Dell, Flagstaff, Santa Rita Mts., Santa Cruz Valley, Nogales, Sabino Can., Herford, Patagonia, June 24, Long Val., Chiric Mts., July 8, Oak Creek Canyon, Aug. 9, Oracle Jct., April 29; (Oregon) Dixie, July 8; (California) Round Valley, July 27.

Notes: Range, in the western states.

55. *Paraphlepsius bipartitus* (DeLong)

Phlepsius bipartitus DeLong, Trans. Amer. Ent. Soc., vol. 52, 1926, p. 90.

Resembling *carolinus* in body form and coloration but darker in color markings, crown slightly produced and angled with front; aedeagal shaft stout, dorsoposteriorly directed with an upturned apical foot in lateral view; a pair of long prongs from base of aedeagus curving anteriorly, then posteriorly to beyond aedeagal apex; a short beak on lower posterior corner of male pygofer; female seventh sternum similar but posterior lateral angles slightly more rounded.

Genitalia: Female seventh sternum three-fourths as long as wide, lateral margins posteriorly converging from base, posterior lateral angles strongly produced, their inner basal margins almost paralleling lateral sternum margins and lie somewhat below the elevated middle disc, posterior marginal middle with a shallow median notch. Male in lateral view: Pygofer, parallelogram-shaped, upper posterior corner rounded, a short ventral beak at lower posterior corner, greatest width of pygofer two thirds its length. Aedeagal base, nearly upright, its shortest length about aedeagal length; aedeagal shaft with basal width of one fourth aedeagal length, diminishing on its lower third into a stout posterodorsally inclined portion, and terminating in an upturned short foot, about as long above shaft as shaft depth proximal to foot; stout pair of pronglike processes arise anteriorly from base margin, then curve back dorsally and posteriorly, almost paralleling shaft to slightly beyond the apical foot. In

dorsal view: Aedeagal base greatly expanded giving rise anteriorly to base of processes and laterally to prominent apodemes, apex bulbous. Connective Y-shaped; shaft wide, its length about arm length.

Types: Holotype male, Paradise Key, Florida, April 4, 1921, D. M. DeLong. Paratypes, one male and two females, same locality, April 4-10, 1921, same collector, one female paratype, Orlando, Fla., April 29, 1921, D. M. DeLong. Types deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Connecticut) Storrs, Aug. 14, Danbury; (New Hampshire) Boscawen, Aug. 12; (Georgia) Okefenokee Swamp, July 25, Adel, Aug. 11; (North Carolina) Tryon; (Florida) Tallahassee, Orlando, Big Pine Key, Mar. 15, Palm Beach; (Tennessee) Chattanooga, July 7; (Alabama) Decatur, July 6; (Mississippi) Shuqualak.

Notes: Range, along Atlantic Coast southward to Florida and somewhat westward in southern states. Swept from grasses in Florida according to DeLong (1926).

56. *Paraphlepsius tubus* (Ball)

Phlepsius tubus Ball, Canadian Ent., vol. 41, 1909, p. 78.

Resembling *fuscipennis* in body form and coloration but with narrower crown and shorter body, eyes reddish brown, and general color tawny; aedeagus in lateral view broad, tapering to distinct apical hook with its arch upward, apex ventral; heavy pair of curved prongs from aedeagal base, running along dorsal margin to sharpened apices near shaft apex; female seventh sternum with posterior lateral angles produced slightly beyond pair of median lobes separated by a wide, V-shaped excavation.

Genitalia: Female seventh sternum about half as long as wide, lateral margins converging on their posterior third, posterior lateral angles produced, median to which a second pair of produced lobes is separated by a wide V-shaped notch, its depth about two fifths distance to base. Male in lateral view: Pygofer about rectangular, posterior marginal middle roundly convex with acute corners above and below, greatest width of pygofer about two-thirds its length. Aedeagal base upright, its shortest length about one-third aedeagal greatest length; aedeagal shaft with basal width of about two-sevenths aedeagal length, posteriorly directed, diminishing and curving slightly dorsad to its truncate apex with a dorsally produced pair of short hooks which curve posteriorly and ventrally in short curvature to sharpened apices; a short stout median process produced

dorsally on apical half with gonopore at its apex; pair of stout prong-like processes about aedeagal length arise from dorsal base border to parallel upper aedeagal margin to a tapered apex. In dorsal view: Aedeagal shaft wider on apical two thirds and excavated apically by a rectangular notch, with the paired hooks appearing straight from the lateral edges of margin of notch sides; prong processes slender, diverging on apical half. Connective Y-shaped with arms converging anteriorly; shaft wide and about one third arm length.

Types: Lectotype male, Washington, D. C., Feb. 7, here designated, and syntype female same location and time. Types in collection of E. D. Ball deposited in U. S. National Museum. Metatype male on hand for study.

Material studied: (Maryland) Annapolis; (D. C.) Washington, Aug. 11; (Virginia) (North Carolina) Raleigh, Aug. 31, Nelson; (Florida) Sanford, July 12, Fort Walton, Pensacola, July 26; (Mississippi) Fort Gibson, Fulton, Aug. 20; (Louisiana) Hosston, June 16.

Notes: Range, across southeastern states from Louisiana to Washington, D. C., and southward into Florida. Occurs on small grasses of pine woodland (DeLong 1926).

57. *Paraphlepsius lobatus* (Osborn)

Phlepsius lobatus Osborn, Proc. Iowa Acad. Sci., vol. 5, 1898, p. 247.

Resembling *truncatus* in body form and coloration but slightly smaller, vertex of crown more conical, coloration uniform; aedeagal shaft in lateral view a stout posteriorly directed process terminating in an avicephaliform apex with a long tapering ventral beak, in dorsal view, bifid; pair of parallel processes running from aedeagal base along dorsal shaft margin to near its apex; female seventh sternum with median lobes roundly produced and separated by a short incision, posterior lateral angles narrowly and acutely produced.

Genitalia: Female seventh sternum about three fourths as long as wide, lateral margins strongly converging from base, posterior lateral angles strongly and narrowly produced, posterior margin slightly convex with produced median lobes separated by a small notch. Male in lateral view: Pygofer about quadrate, a stout dorsally directed hook at upper posterior corner and an acute lower posterior corner, posterior margin convex. Aedeagal base inclined anterodorsally, its length about fourth aedeagal length, preatrium scarcely present; aedeagal shaft with basal width about equal to base length,

posteriorly directed, diminishing on proximal half to a stout apical half and terminating in a rounded apex with pair of long tapering ventral beaks subapically placed; pair of tapering pronglike processes about equal to aedeagal length arise at upper base border and parallel aedeagus to their dorsally curved apices. In dorsal view: Aedeagus twice wider basally than along stout shaft, base rounded anteriorly, apex deeply bifid; short posterior lateral apodemes prominent; prong processes about parallel. Connective Y-shaped with arms close but diverging apically; shaft broad, its length about half arm length.

Types: Cotypes, male and female, Little Rock, Iowa, July 2, 1897, E. D. Ball, deposited in Ohio State University Entomological Collections. Types studied.

Material studied: (Wisconsin) Merrillan, Sparta; (Iowa) Thompson, Sept. 15; (Kansas) Onaga, Douglas Co., Wyandotte County, June 22; (Louisiana) Venice, June 22.

Notes: Range, across central states.

58. *Paraphlepsius torridus* (Lathrop)

Phlepsius torridus Lathrop, Ohio Jour. Sci., vol. 17, 1917, p. 126.

Resembling *attractus* in body form and coloration, but body larger, vertex of crown more conical, coloration uniformly mottled with fuscous; aedeagal shaft in lateral view with the dorsal part of avicephaliform apex projected prominently above shaft; aedeagal pronglike processes paralleling main shaft at considerable distance above shaft; pygofer beak at upper posterior corner more posteriorly located than beak at lower posterior corner of pygofer; female seventh sternum with posterior lateral angles moderately produced with small median lobes from convex posterior margin extending posterior to lateral angles.

Genitalia: Female seventh sternum about half as long as wide, lateral margins slightly converging from base, posterior lateral angles moderately produced, posterior marginal middle obtusely produced slightly beyond lateral angles, with small median notch. Male in lateral view: Pygofer somewhat rectangular, a stout short beak at upper posterior corner and small ventral beak on lower margin at anterior edge of the lower rounded posterior corner, greatest width of pygofer about five sevenths its length. Aedeagal base about upright, its shortest length about two fifths aedeagal length, strongly concave below with lower marginal half curving anteriorly and upward along an extended preatrium to articulation; aedeagal shaft with basal depth of about base length, posteriorly directed, progres-

sively diminishing to a constricted "neck" subapical to an avicephaliform apex near posterior margin of pygofer; a pair of stout dorsoposteriorly directed pronglike tapering processes arising at upper base border curving slightly downward on proximal third, then following upper contour of shaft to beyond its apex about even with plate apices, the tapered apex slightly curved upward. In dorsal view: Aedeagus twice wider at base and on swollen apical half than along constricted lower half, apex concavely notched; posterolateral apodemes slender. Connective shaft Y-shaped with slender arms converging subapically, then diverging apically; shaft broad, its length about one sixth arm length.

Types: Destroyed by fire in 1925 according to Dr. F. H. Lathrop. Metatype female, Raleigh, North Carolina, October, 1909, in Herbert Osborn Collection deposited in Ohio State University Entomological Collections. Autotype studied.

Material studied: (Maryland) Annapolis; (Virginia) Cape Charles; (North Carolina) Raleigh, Aug. 31, Walnut; (Georgia) Okefenokee Swamp, July 27; (Florida) Hilliard, Aug. 6; (Alabama) Birmingham.

Notes: Range, in the southeastern states.

59. *Paraphlepsius umbrosus* (Sanders and DeLong)

Phlepsius umbrosus Sanders and DeLong, Ann. Ent. Soc. Amer., vol. 10, 1917, p. 88.

Resembling *incisus* in body form and coloration, vertex of crown longer at middle and more conical, margin obtusely angled, coloration darker brown; aedeagal shaft in lateral view with apical end with dorsal rectangular projection and narrow ventral beak, aedeagal pronglike processes straight; pygofer rectangular with beaks at lower and upper posterior corners; female seventh sternum almost as long as wide, posterior lateral angle only slightly produced, posterior margin convex with a small median V-shaped notch.

Genitalia: Female seventh sternum two thirds as long as wide, lateral margins converging from base, posterior lateral angles slightly and acutely produced, posterior margin slightly convex with a deep V-shaped medial notch. Male in lateral view: Pygofer somewhat rectangular, upper margin roundly sloping downward posteriorly to an anterodorsally directed sharp beak slightly anterior to rounded posterior margin, a stout beak at lower posterior corner, greatest width of pygofer about two thirds its length. Aedeagal base nearly upright, its shortest length about one third aedeagal length, concave below with lower marginal third curving anteriorly and up-

ward along the preatrium to articulation; aedeagal shaft with basal width of slightly more than base length, posteriorly directed, diminishing in width to one-third basal depth subapically, apex with a dorsal quadrate process, and a pair of slender posteroventral beaks; pair of straight tapering prong processes arise from dorsal base portion, extend posteriorly above aedeagal shaft and terminate about even with apical beaks. In dorsal view: Aedeagus swollen on basal and apical halves, slightly more basally, apex excavated by a shallow quadrangular notch; prong processes approach each other on their middle then diverge apically. Connective Y-shaped with arms roundly spread, apical fourth narrowed and turned outward; shaft broad, its length about one half arm length.

Types: Female and two male cotypes, Grand Rapids, Wisconsin, Aug. 21, 1916, J. G. Sanders, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: Only type material.

Notes: Range, in north central states.

60. *Paraphlepsius collitus* (Ball)

Phlepsius collitus Ball, Canadian Ent., vol. 35, 1903, p. 227.

Resembling *fulvidorsum* in body form and coloration but crown short, obtusely rounded on vertex; aedeagal shaft in lateral view departing posteriorly from upper part of a wide base and curving upward to a small avicephaliform apex; a pair of prongs from base of aedeagus separating in a rounding curve to their apices; female seventh sternum with posterior lateral angles strongly and roundly produced, median lobes close, small and slightly produced.

Genitalia: Female seventh sternum about five ninths as long as wide, lateral margins roundly converging from base, posterior lateral angles strongly produced, median produced lobe with a small rounded notch on posterior margin. Male in lateral view: Pygofer trangular; upper margin sloping angularly from upper anterior corner to a blunt posterior angle with a short ventral beak below, an anterodorsally directed spinelike process arising inside posterior angle, and following below upper pygofer margin, spine length about half pygofer length, greatest width of pygofer about three fourths its length. Aedeagal base about upright, its length about half aedeagal length, preatrium from articulation curves upward expanding to shaft above; aedeagal shaft dorsoposteriorly directed, departing upper base with basal depth of one third base length, curving dorsad on apical half and terminating in a blunt apex with

short ventral beak; pair of long tapering posteriorly directed spines arise basally below shaft and terminate below aedeagal apex. In dorsal view: Aedeagus three times wider basally than along shaft proper; tapering spinelike processes diverge from base in rounding arcs; lateral apodemes stoutly prominent. Connective Y-shaped with roundly separated arms, their apices turned outward; shaft broad, its length about one third arm length.

Types: Lectotype female, Exp. Sta., Ames, Iowa, August 27, 1897, E. D. Ball, here designated, and two syntypes with same labeling. Types in collection of E. D. Ball deposited in U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Materail studied: (Maine) Orono, Bar Harbor, S. Portland; (New Hampshire) Durham, Notchland, Aug. 20; (Massachusetts) Woods Hole, Wellesley; (New Jersey) West Field, Orange; (New York) West Nyack, Babylon; (Maryland) Laurel; (D. C.) Washington; (North Carolina) Raleigh; (South Carolina) Conestee; (Pennsylvania) Numidia, August 21, Cameron, August 21; (Georgia) Tifton, Prattsburg, August 23, Okefenokee Swamp, Thompson Mills; (West Virginia) Fairmont; (Kentucky) Jellico; (Florida) Jacksonville, Suwannee Springs, July 29, Suwannee Co.; (Ohio) Hocking Co., Delaware County, Champain County, Asbula County, Columbus, Marietta, Fairfield County; (Tennessee) Elkton, Clarksville, July 17, Hamilton County; (Alabama) Tuskegee, July 22, Brunsville, Decatur, Clarksville; (Mississippi) Biloxi, Vicksburg, Columbia, Ocean Springs, Woodville, Forest County, Durant, Meridian; (Michigan) Chebougan, July 14, St. Ignace; (Wisconsin) Amery, Portage, Osceola, Grand Rapids, East Troy, August 10; (Missouri) Noel, July 4, Pineville; (Kansas) Hutchinson, Medora, Douglas County, June 21, Elk City, Galena; (Oklahoma) LeFlore County, May 24, Tuskahoma; (Arkansas) Fayetteville, Scott County, Washington County, June 30, Polk County, August 21, Texarkana; (Louisiana) Winn County, Hammond, June 22, Calcasieu County; (Texas) Brazos County, Quinlan, Orange County, August 14.

Notes: Range, in most of states east of Rocky Mountains. DeLong (1926) states that this species is found abundantly on short growths of *Juncus, Elecharis obtusa* and *Scleria verticellata* on margins of freshwater lagoons where waves keep the sand wet. Also DeLong (1926) lists it as a meadow species of northern states.

61. *Paraphlepsius attractus* (Ball)

Phlepsius attractus Ball, Canadian Ent., vol. 16, 1909, p. 77.
Phlepsius graniticus Osborn and Lathrop, Ent. Soc. Amer. Ann., vol. 16, 1923, p. 317.

Resembling *floridanus* in body form and coloration but with more pointed vertex of crown, darker brown in coloration, and fewer black spots on costa of wing; aedeagal shaft with ventral beak at apex and with pair of long prongs, paralleling dorsal border reaching apex of aedeagal shaft; female seventh sternum with posterior median lobes moderately produced and their margin darkened.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins rounded, posterior lateral angles produced slightly, a median wide obtuse bifid lobe on posterior margin. Male in lateral view: Pygofer nearly rectangular, narrowing posteriorly with anteriorly pointed beak at upper posterior corner and blunt point at lower posterior corner, greatest depth half its length. Aedeagal base upright, its length about half aedeagal length, aedeagal shaft posteriorly directed, diminishing from a basal depth of about base length to a stout dorsally inclined apical half which terminates in a truncate apex with a pair of ventral beaks near dorsal pygofer hook; a pair of slender tapering processes, posteriorly directed, arise from dorsal median edge of aedeagal base and follows above the general contour of aedeagus to slightly beyond its apex. In dorsal view: Aedeagal basal and apical halves swollen roundingly and apical beaks turned outward. Connective Y-shaped; shaft broad, its length about arm length.

Types: Lectotype male, Biscayne Bay, Florida, E. D. Ball, here designated, and one syntype male with same labeling. Types in collection of E. D. Ball deposited in U. S. National Museum. Specimens compared to types by Dr. P. W. Oman.

Material studied: (Virginia) Cape Henry; (North Carolina) Shallotte, Franklin; (Georgia) Okefenokee Swamp, Aug. 3, Prattsburg, Waycross, Hinesville, Houston County, Folkston; (Florida) Hilliard, August 31, Ft. Pierce, Sanford, LaBelle, July 16, Ft. Myers, Ponce de Leon, Deerfield, Royal Palm Park, Orange Grove, Suwannee Springs, Wakullah, Cedar Keys, Key West, Melbourne, Mar. 17, Homestead, Gainesville, Eridu, Naples; (Alabama) Escambia County; (Mississippi) Orange Grove, July 10.

Notes: Range, along Atlantic Coast from New England to Florida. Habitat (DeLong, 1926) in short grass of pine forest floor. "Pitch pine" noted on label of specimen collected in New Hampshire by

P. R. Lowery. Dr. Ball (1931) states that *P. attractus* and *P. floridanus* were founded on head characters of the same species, and belong in synonymy under *attractus*. *P. floridanus* should never have been considered in synonymy since the male genitalia are distinct.

62. *Paraphlepsius solidaginis* (Walker)

Acocephalis solidaginis Walker, List. Homop. Ins. Brit. Mus., vol. 3, 1851, p. 847.
Phlepsius nebulosus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 77.

Resembling *humidus* in body form and coloration but body longer, narrower and vertex of crown slightly more produced; aedeagal shaft in lateral view more slender, forming an arched shaft above posterior half of pygofer; pygofer hook from upper margin twice longer than in *humidus;* female seventh sternum with posterior lateral angles moderately produced, posterior margin about truncate with a small median notch.

Genitalia: Female seventh sternum two thirds as long as wide, lateral margins converging from base, posterior lateral angles moderately produced, middle of posterior margin almost truncate with slight median notch. Male in lateral view: Pygofer triangular in shape, upper posterior corner cut away by a posteroventrally sloping margin, below and inside upper margin on posterior one third, a stout hook arises and is directed medianly, then posteriorly, terminating about even with plate apex. Aedeagal base dorsoposteriorly directed, its length about one fourth aedeagal length, concave with lower marginal two-thirds curving anteriorly along preatrium to articulation; aedeagal shaft a large arching hook, continuous dorsally from preatrium, then curving posteriorly and ventrally in a large curvature to a rounded apex, a pair of teeth on posterior border of proximal part of shaft. In dorsal view: Aedeagus broadest at base; shaft tapering slightly to a bluntly bifid apex. Connective Y-shaped, with arms converging on apical third, apices turned outward; shaft length about equal to arm length.

Types: Deposited in British Muesum (Natural History). Lectotype female of *P. nebulosus* studied and specimens were compared to *A. solidaginis* types by Dr. W. E. China of the British Museum.

Material studied: (New Jersey) Mt. Pleasant; (Ohio) Worthington; (Manitoba) Hartney, Woodside, Oakner, July 31, Shoal Lake; (Michigan) Cheboygan County, July 12, Huron County; (Illinois) Chicago; (Iowa) Ames, Little Rock; (North Dakota) Tokio, July 28; (Nebraska) Lincoln; (Kansas) Ellsworth County, July 18, Douglas County, June 26, Decatur County, Kiowa County,

Hodgeman County, Scott County, Republic County, Rawlins County, Thomas County; (Colorado) Fort Collins, July 14.

Notes: Range, in northern plains states and eastward. In regard to habitat, DeLong (1926) states that *P. solidaginis* approaches a swamp form as it is common on tall *Carex-Phragmites* in freshwater marsh associations.

63. *Paraphlepsius humidus* (Van Duzee)

Phlepsius humidus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 76.
Paraphlepsius ramosus Baker, Canadian Ent., vol. 29, 1897, p. 158.
Phlepsius tenuifrons Sanders and DeLong, Ann. Ent. Soc. Amer., vol. 12, 1919, p. 235.

Resembling *solidaginis* in body form and coloration but crown and body length slightly shorter and broader; aedeagal shaft in lateral view as a "sickle" with apical half curved ventrally, tapering to pointed apex; pygofer hook short as it extends posteriorly from upper margin; female seventh sternum with posterior lateral angles not produced and median pair of lobes moderrately produced.

Genitalia: Female seventh sternum about two thirds as long as wide, lateral margins converging slightly on basal half and more so on their posterior half to rounded, slightly produced lateral angles, posterior margin with two median small lobes separated by a deep incision. Male in lateral view: Pygofer nearly triangular, posterior angle rounded, above which the upper margin is continuous posteriorly with a stout straight tapering spine, its apex about even with plate apices, greatest width of pygofer two thirds its length. Aedeagal base about horizontal, length almost third aedeagal length; preatrium deep and continuous posteriorly with an arching sicklelike shaft; aedeagal shaft with basal depth about half base length, posteriorly directed, tapering as it curves rather abruptly ventrad on proximal third to sharpened apex below pygofer shaft, apical two thirds rather straight about as long as pygofer width at middle. In dorsal view: Aedeagus twice wider basally than along shaft; lateral apodemal processes long and stout. Connective Y-shaped with arms converging on apical half then turned outward apically; shaft broad, its length about one fourth arm length.

Types: Lectotype male, Lancaster, N. Y., Aug. 1896, E. P. V. in Iowa State College Entomological Collections designated by P. W. Oman (1946); two female syntypes with above data in same collections; one male syntype, N. Y., E. P. V., two female syntypes, Buffalo, N. Y., Aug. 2, 1886, E. P. V., and one female syntype, Ridgeway, Ont., Aug. 7, 1886, E. P. V. in same collections.

Material studied: (Ohio) Medina Co., Aug. 28; (Iowa) Experiment Station, Aug. 21; (Missouri) Webster Groves, Aug. 25.

Notes: Range, in northern and northwestern states. Apparently two species were confused among the cotypes. *P. ramosus* Baker 1897 is synonym of *P. humidus* Van Duzee 1892.

64. *Paraphlepsius carolinus* (Lathrop)

Phlepsius carolinus Lathrop, Ohio Jour. Sci., vol. 17, 1917, p. 127.

Resembling *brunneus* in body form and coloration but pronotum only moderately arched and coloration lighter; aedeagal base quadrate in lateral view, bearing pair of short lateral posteriorly directed prongs and shaft extending posteriorly from upper part of base as an arched hook; pygofer quadrate; female seventh sternum with strongly produced posterior lateral angles turned medially, posterior margin betwen angles as two broadly rounded lobes separated by a shallow notch.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins converging strongly on their posterior halves, posterior lateral angles strongly produced with apices slightly notched on inner margins, middle posterior margin roundingly convex with widened median notch. Male in lateral view: Pygofer quadrate with short dorsal beak at upper posterior corner and a short point at lower posterior corner. Aedeagal base upright, its length about half aedeagal length, its lower marginal fourth curving anteriorly along the preatrium to articulation; aedeagal shaft with basal depth about equalling base length, is posteriorly directed, its lower margin curving dorsad and posteriorly to a sharp posterior corner then dorsad to slender tapering shaft proper which arches upward terminating about even with plate apices; heavy spines about as long as base length and posteriorly directed arise about middle of deeper basal portion of shaft. In dorsal view: Aedeagus much wider basally, narrowing on basal third to apical portion of shaft; lateral apodemes prominent. Connective Y-shaped with arms roundingly spread; shaft broad, its length about two fifths arm length.

Types: Destroyed by fire in 1925 according to Dr. F. H. Lathrop, but specimens in possession of Dr. D. M. DeLong were compared with types. Compared to type material studied.

Material studied: (Maryland) Plummer's Island; (North Carolina) Raleigh; (Georgia) Neal Gap, Sept. 20, Peach County; (Kentucky) Cadiz, June 30; (Tennessee) Clarksville, July 19, Oct. 26,

Elkton; (Tennessee) Knoxville; (Alabama) Decatur, July 6; (Mississippi) Iuka, Fayette.

Notes: Range, in southeastern states. DeLong (1926) states that upland pastures of *Andropogen virginicus* is a common habitat.

65. *Paraphlepsius optatus* (Crumb)

Phlepsius optatus Crumb, Ann. Ent. Soc. Amer., vol. 8, 1915, p. 194.

Resembling *fulvidorsum* in body form and some coloration but vertex of crown less produced and coloration pale and uniform except for distinct dark areas at posterior point of clavus and at end of claval veins; aedeagal shaft in lateral view extremely slender, curving anteriorly then dorsally arching in a long slender hook with apical portion directed ventrally; female seventh sternum small with posterior margin roundly concave and notched slightly on its middle.

Genitalia: Female seventh sternum almost two thirds as long as wide, lateral margins converging sinuately from base, posterior lateral angles moderately produced with their inner margins sloping obliquely to a truncate posterior margin on middle third. Male in lateral view: Pygofer irregularly rectangular, greatest depth five sevenths length, upper posterior marginal third sloping concavely to a turned up bluntly rounded point posteriorly, posterior margin about half pygofer depth, a small beak at lower posterior corner. Aedeagal base, extremely concave with the preatrium seeming to extend from articulation posteriorly, then curve back above connective shaft a distance of depth of concavity to right angled corner, continuous with shaft above; aedeagal shaft slender, sicklelike, arising dorsally at anterior edge of base, curves posteriorly and ventrally in a large arc, terminating in tapered apex. In dorsal view: Aedeagus greatly expanded basally below a slender dorsal shaft, posterodorsal apodemes prominent from posterior base border. Connective Y-shaped; shaft expanded at apex, its length about three fifths arm length.

Types: Male lectotype, Clarksville, Tenn., June 8, 1914, S. E. Crumb here designated; one male and three female syntypes, same location, date, and collector. Types deposited in Snow Entomological Collections, University of Kansas.

Material studied: (Kentucky) (Tennessee) Clarksville, May 28, June 6, Covington, Bells; (Texas) Brownsville, June 29, July 3, Cameron County, August 3; (Mississippi) Lexington, July 15; (Louisiana) Baton Rouge, April 18, Covington, June 23; (Florida)

Morrison Field, November 2; (Kansas) Douglas County, June 27.
Notes: Range, in states from Texas to Tennessee.

66. *Paraphlepsius pusillus* (Baker)

Phlepsius pusillus Baker, Ent. News, vol. 9, 1898, p. 66.
Phlepsius collinus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 324.

Resembling *altus* in body form and coloration but smaller and color pale fulvous, finely irrorate; aedeagal shaft in lateral view a broad sickle-like hook with tapered apical part directed ventrally; female seventh sternum with posterior margin broadly truncate between two slightly produced posterior lateral angles and notched on its middle.

Genitalia: Female seventh sternum half as long as wide, lateral margins converging from base, posterior lateral angles slightly produced, middle two thirds of posterior margin truncate with a V-shaped median notch. Male in lateral view: Pygofer somewhat quadrate with a dorsally directed hook from lower posterior corner. Aedeagal base inclined posteriorly, concave with anterior marginal half curving upward along the preatrium to articulation; aedeagal shaft stout "sickle-shaped," with basal width of almost half base length, is posteriorly directed on proximal two thirds then curving ventrally on apical third and tapering to apex near base of posterior pygofer hook. In dorsal view: Aedeagus broad, apex bluntly bifid; lateral apodemal horns long. Connective Y-shaped with stout widely separated arms, apically reduced; shaft short, only one fourth arm length.

Types: Lectotype male, Caton's Bush, Maryland, Sept. 25, here designated; syntype male, Odenton, Maryland, Sept. 20. Types in Uhler Collection deposited in U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Connecticut) New Haven, Aug. 16; (New Jersey) Anglsea, Lakehurst; (Maryland) Ashton, Beltsville, Aug. 25; (D. C.) Washington; (Virginia) Vienna, Aug. 20; (North Carolina) Oxford, July 28; (Tennessee) Magnolia, September 24, Clarksville, October 8; (Kansas) Lawrence, September 20.

Notes: By mistake, *P. pusillus* types in the U. S. N. M. were labeled *P. mimus* (therefore no *pusillus* types appeared); checking of localities on label both *mimus* and *pusillus* types exist and *pusillus* agrees with its description by C. F. Baker as well as with *P. collinus* Osb. and Lath. (Ball 1927).

67. *Paraphlepsius occidentalis* (Baker)

Phlepsius occidentalis Baker, Ent. News, vol. 9, 1898, p. 66.

Resembling *nudus* in body form and coloration but with crown less depressed and body longer; aedeagal shaft in lateral view a large sickle-like structure with anterodorsally directed handle continuous dorsally with the arched portion which curves ventrally to the sharpened apex; female seventh sternum with strongly produced narrow median lobe notched slightly, posterior lateral angles slightly produced.

Genitalia: Female seventh sternum about seven twelfths as long as wide, lateral margins strongly converging from base, posterior lateral angles nearly truncate and only slightly produced, middle third of posterior margin moderately produced into a slightly bifid median lobe. Male in lateral view: Pygofer rather rectangular, upper margin sloping posteriorly to an anteriorly directed short beak, the upper margin of which continues in a steep slope to a blunt rounding point on middle of posterior margin, lower posterior margin roundly curved to blunt posterior point, greatest width of pygofer about seven tenths its length. Aedeagal base margin a very deep oval concavity, its lower marginal two fifths curves anterodorsally along the preatrium to articulation, shortest base length across opening of concavity about one ninth aedeagal length; preatrium continuous posteriorly with an anterodorsally directed "sickle handle," its length about third aedeagal length; aedeagal shaft stout, curving dorsally, posteriorly, and ventrally in a long curved sicklelike portion to termination about even with plate apices. In dorsal view: Aedeagal base nearly five times wider than slender "sickle" shaft; apodemal horn posterolaterally directed. Connective Y-shaped; arms spreading proximally, converging subapical, then turned outward at apex; shaft broad, its length about equal to arm length.

Types: Holotype female in Uhler Collection deposited in the U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (British Columbia) Lytton, Merritt, Aug. 3; (Montana) Anoconda, Aug. 12, Missoula, Merritt; (Idaho) Bliss, July 7; (Utah) Logan, Salt Lake City, Granit, Logan Canyon; (Washington) Pullman, Mt. Rainier, Naches; (Oregon) Dixie, July 8, Corvallis, Medford, Portland, August 12; (California) Winters, Golden Gate, Alpine, Coleville, Leona Heights, Berkeley, September 3, October 3, Arroyo Seco River, August 8, La Jolla, July 7, Pine Valley, Redding, June 28, San Jacinto Mts., Boulder Creek,

Monterey, Lafayette, Cuyamaca Lake, Mt. Talmapais, Stimson Beach, Lompoc, Jamesburg, Upper Lake, Irvine Park, Nicolaus, Mineral, Oak Grove, Santa Rosa Mts., Stanford, Spreckels, Chico, Weed, Madera Co., San Luis Obispo, Honda, Paynes Cr., Sequoia N. For., Yosemite, Ontario, Hamilton, Gridley, Watsonville, San Margreta.

Notes: Range, in California and northward in Pacific Coast states as far as British Columbia.

68. *Paraphlepsius eburneolus* (Osborn and Lathrop)

Phlepsius eburneolus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 331.

Resembling *fulvidorsum* in body form and coloration but with vertex of crown shorter and ivory colored anterior portion of body more distinctly contrasting with the dark elytra; aedeagal shaft in lateral view with a quadrate base continuous with a long arched "sickle-like" hook with apical portion curving ventrally to sharpened apex; female seventh sternum with pair of median lobes broadly rounded and about evenly produced with the moderate posterior lateral angles.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins gradually converging from base, posterior lateral angles moderately produced, posterior margin slightly convex with a median notch, incised anteriorly a distance of about twice notch depth. Male in lateral view: Pygofer about five eighths its length. Aedeagal base concavely V-shaped with atrial half about upright and lower margin curving anteriorly along the preatrium to articulation, shortest length of base about one fourth aedeagal length; aedeagal shaft quadrate on proximal fourth, basal width one fourth greater than base length, shaft continuing above from quadrate portion as a long arched posteriorly directed tapering portion, terminating near posterior angle of pygofer. In dorsal view: Aedeagus widest basally along quadrate portion, apical shaft slender; blunt dorsolateral apodemes prominent. Connective Y-shaped; shaft wide, its length about one third arm length.

Types: Holotype female, Vinita, Ind. Ter., June 8, 1899, W. F. Wickham; allotype male and female paratype, Askburn, Va., L. A. Sterns. Types deposited in Ohio State University Entomological Collections. Types studied.

Material studied: (Manitoba) Mafeking, August 3; (Maine) Lake Sebago, August 20; (Minnesota) Minneapolis, Itasca Park, August 11; (Kansas) Anderson County, Atchison County, July 7.

Notes: Range, in northern states and Canada east of the Rockies. A very distinct species with yellowish head and thorax contrasted with darker wings.

69. *Paraphlepsius apertinus* (Osborn and Lathrop)

Phlepsius apertinus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 329.

Resembling *excavatus* in body form and coloration but coloration darker and more distinct; aedeagal apex sagittate in dorsal view; female seventh sternum with base of excavation wider than posterior part of excavation and wider than base of lateral half.

Genitalia: Female seventh sternum about half as long as wide, lateral margins concavely converging on their posterior half, posterior lateral angles not produced, a wide deep median excavation to base, its wider basal width about one-third greater than base of lateral piece, corners at margin of excavation opening acute. Male in lateral view: Pygofer quadrate, with stout spinelike hook from lower posterior corner curving dorsoposteriorly to sharpened apex, hook length about half pygofer depth. Aedeagal base dorsoposteriorly inclined, its shortest length about half aedeagal length, concave on lower three fourths with lower marginal half curving anteriorly to articulation along the preatrium; aedeagal shaft with basal depth of two thirds base length, lower margin forming a posterior protuberance, then curving dorsally as ventral margin of the stout shaft proper which terminates in a sharpened apical third with ventrally curved beak at apex, two pairs of retrorse teeth on upper margin, one pair at anterior edge of apical third and the other nearer apex. In dorsal view: Aedeagus with shaft sides about parallel slightly wider than base, apical portion broadly sagittate with two pairs of lateral retrorse teeth, apex pointed. Connective Y-shaped; shaft length about half arm length.

Types: Holotype female, Corvallis, Oregon, July 4, 1917, unfortunately burned in a fire. Allotype male, Corvallis, Oregon, July 4, 1917, Herbert Osborn, and paratype female Palo Alto, California, Aug. 24, 1892, Herbert Osborn, deposited in Ohio State University Entomological Collections. Types studied at Ohio State University.

Material studied: (Oregon) Pendleton, July 11; (California) Santa Cruz, Arroyo Seco R., Aug. 8, Inspiration Point, Sept. 30, Snowline Camp in Eldorado Co., July 3, Miami Ranger Station in Mariposa Co., May 22, Pine Valley, Clayton, Giant Forest, Devil's Basin, Palo Alto, Sequoia National Park, June 11, Winters.

Notes: Range, along West Coast and apparently closely related to the new species *P. excavatus* but darker in coloration. Not same as *P. apertus* as suggested by E. D. Ball (1927).

70. *Paraphlepsius excavatus* sp. nov.

Resembling *Paraphlepsius apertinus* (Osborn and Lathrop) in general appearance but lighter in color on anterior third of dorsum, aedeagal apex not sagittate in dorsal view, base of excavation in female sternum about equaling base of a lateral half. Length male 6.5 mm.; female 6.75 mm.

Structure: Crown almost twice longer at middle than next to eye, depressed basally, acutely angled with front, its apex in dorsal view bluntly acute. Pronotum very slightly convex. Elytra laterally compressed near apex of clavus but slightly flaring apically. Clypeus depressed basally, very slightly narrowing below to antennae then converging to clypellus. Clypellus narrow, slightly wider at apex than at base.

Color: Yellowish brown irrorations on crown, pronotum, and scutellum. Elytra with light brown to dark brown pigment lines and irrorations, an irregular light band before middle of clavus and extending to costal border, a few white ivory spots on elytra, a series of blackish spots on costa. Face brownish, darker on clypeus with about three whitish irregular arcs broken at middle, light spots at outer border of lora and on genae at upper tip of lorae.

Genitalia: Female seventh sternum about half as long as wide, lateral margins slightly converging from base, posterior lateral angles not produced, middle of sternum excavated to base with toothlike corners at opening at posterior margin, excavation constricted slightly posterior to middle, basal width of excavation about equalling base of lateral sternum half. Male valve triangular, obtusely angled at apex. Plates widest at base, narrowing laterally to apical third, apex rounded, in lateral view apical third turned up medially to a spatulate apex. Male in lateral view: Pygofer quadrate, with upturned stout spine from lower posterior corner, its length about half pygofer width. Aedeagal base nearly upright, its length about three fifths of aedeagal length, lower marginal third curves anteriorly along the preatrium to articulation; aedeagal shaft basal width about one third aedeagal length, a medial protuberance at lower posterior margin, above which the stout shaft is directed dorsoposteriorly terminating in a sagittate apical third with pair of retrorse teeth at its upper margin and a median tooth on lower margin of apical third. In dorsal view: Aedeagus broad-

est at base, expanded into prominent posterolateral horns, apical fourth with usually three pairs of short retrorse teeth on lateral margin, connective Y-shaped; shaft length about half arm length.

Types: Holotype, allotype, and thirteen male and sixteen female paratypes, Monterey, California, July 22, 1935, R. H. Beamer. Other paratypes: Two males, Lafayette, California, July 14, 1933, R. H. Beamer; two females, Yosemite Nat'l Park, California, August 1, 1940, D. E. Hardy; one male and one female, Ft. Lewis, Washington, July 5, 1935, P. W. Oman; seven males and five females, Salinas, California, June 20, 1908, E. D. Ball; one male and three females, Spreckels, California, Oct. 5, 1907, Titus and Ball; three males and one female, Camino, California, June 23, 1948, J. W. MacSwain; five females, Davis, California, July 17, 1942, W. N. Stiner. Holotype, allotype, and paratypes deposited in Snow Entomological Collections, University of Kansas; paratypes deposited in U. S. National Museum; paratypes in University of California Entomological Collections; and paratypes in Cornell University Entomological Collections.

Material studied: (Washington) Ft. Lewis, July 5; (Wyoming) Yellowstone Park, July 20; (Oregon) Florence, July 11; (California) Giant Forest, Stanford Univ., Camino, Tulare County, Davis County, Bowman County, Lafayette, Redding, Wheatland, Eldorado, June 23, Strawberry, August 8.

Notes: Range, in California and northward. Large series collected by R. H. Beamer (1935) on Oak near Monterey, California.

71. *Paraphlepsius acutus* sp. nov.

Resembling *Paraphlepsius excavatus sp. nov.* in body form, coloration, and genitalia but vermiculate markings are more uniformly distributed, aedeagal shaft wider than ovate apical third of shaft, female seventh sternum not excavated all the way to base. Length, male, 6.5 mm., female, 7 mm.

Structure: Crown three fourths longer at middle than next to eye, depressed transversely across posterior border and slightly depressed before apex, acutely angled with front, in dorsal view apex about right-angled. Pronotum extended anteriorly between eyes, its posterior margin concave, length almost half as great as width. Elytra very slightly compressed subapically, appendix broad. Clypeus only slightly converging to apical third, then rapidly narrowing to apex, one fourth longer than basal width, slightly depressed below apex of crown. Clypellus rather uniformly widening from base to truncate apex.

Color: Dorsum of body rather evenly covered with vermiculate brownish lines and irrorations, crown with yellowish spot at apex, dark areas on either side. Pronotum slightly blotched with brown. Scutellum with three ivory spots on lateral marginal middle and at apex, bordered by dark brown areas. Elytra evenly marked, a very slight indication of transverse whitish band across clavus, costal spots small but evenly distributed. Clypeus irrorate with brown on yellowish background. Clypellus yellowish, sprinkled with brown.

Genitalia: Female seventh sternum two thirds as long as wide, lateral margins moderately converging from base to rounded lateral angles, middle third of sternum excavated almost to base, posterior half of excavation slightly wider than anterior half, posterior corners of excavation opening acute. Male valve broadly triangular, its sides slightly concave. Plates widest on basal third, narrowing to apical third, apex rounded in ventral view, in lateral view inner margin of apical third turned dorsad into a spatulate form. Male in lateral view: Pygofer quadrate, with a dorsoposteriorly directed hook from lower posterior corner. Aedeagal base dorsoposteriorly directed, its length slightly more than half aedeagal length, strongly concave with lower marginal half curving anteriorly along the preatrium to articulation; aedeagal shaft with basal width of one fourth base length, posteriorly directed, curving slightly upward to a sharpened apex, a subapical pair of teeth on upper margin with smaller teeth along margin toward apex, a posterior median protuberance on basal portion below shaft. In dorsal view: Aedeagus constricted basally, apical half of shaft swollen, wider than ovate toothed area around gonopore. Connective shaft Y-shaped; the shaft expanded at articulation, its length about two-fifths arm length.

Types: Holotype male, allotype female, eleven male and seven female paratypes, LaJolla, California, July 14, 1941, R. H. Beamer. Types deposited in the Snow Entomological Collections, University of Kansas, and paratypes, male and female, in U. S. National Museum.

Material studied: Only type material.

Notes: Range, known only for the LaJolla region in California.

72. *Paraphlepsius apertus* (Van Duzee)

Phlepsius apertus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 76.

Resembling *apertinus* in body form generally and in coloration but body shorter near the *altus* form and genitalia distinctly related to that of *apertinus;* aedeagal shaft in lateral view broad basally and continuous above as a short quadrate form with a ventral beak; female seventh sternum with excavation not reaching its base.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins posteriorly converging, posterior lateral angles slightly produced into rounded lobes, a deep median excavation on posterior margin almost to base, its width about one fifth sternum width but wider basally. Male in lateral view: Pygofer quadrate, with a stout tapering spine from the lower posterior corner, directed posteriorly then dorsally, its length about half pygofer depth. Aedeagal base concavely upright, length about three fifths aedeagal length; aedeagal shaft with basal width slightly more than half aedeagal length, its lower margin forming a rounded ventral bulge posteriorly, then curving dorsally and again posteriorly below an upper quadrate portion, with a pair of ventrally directed beaks. In dorsal view: Aedeagus with three pairs of blunt lateral teeth near subapical gonopore; basal apodemes prominent. Connective Y-shaped; its shaft length about arm length.

Types: Lectotype male, Muskoka, Ont., July, 1888, E. P. Van Duzee, in Iowa State College Collections designated by P. W. Oman (1946). Syntype female, Muskoka, Ont., July, 1888, E. P. Van Duzee, and syntype male Quebec, Canada, collected by Provancher, in same collections. Types studied.

Material studied: (Manitoba) Keld, Mafeking, Aug. 3, Red Deer River, Swan River; (British Columbia) Merritt, Terrace, Port Renfrow; (Maine) Orono; (New Hampshire) Notchland, Aug. 20, Crawford Notch; (New York) Raquette Lake, July 26, Wanakena, Cranberry Lake; (Minnesota) Grand Marais, Fairbanks, Park Rapids, Two Harbors, August 9; (Wisconsin) Brule, August 16; (Michigan) Escanaba, Aug. 20; (South Dakota) Redfield; (Montana) Drummond, August 11, Bennett, Hamilton; (Colorado) Pingree Park, August 18, Cameron's Pass, Muddy Pass; (New Mexico) Carlsbad; (Utah) Strawberry Valley; (Washington) Republic, August 6.

Notes: Range, in northern United States and Canada. Habitat in meadows (DeLong 1926). Related to *P. apertinus* as evidenced by the genital structures of both male and female but not the same as *P. apertinus* as suggested by E. D. Ball (1927).

73. *Paraphlepsius irroratus* (Say)

Jassus irroratus Say, Jour. Acad. Nat. Sci. Philadelphia, vol. 6, 1831, p. 308.
Jassus testudinarius Burmeister, Genera quaedam Insectorum Iconibus Illustravit et Descripsit, vol. 1, heft 2, 1838, [p. 41, pl. 14].

Resembling *attractus* in body form and coloration but larger and irrorate coloration slightly darker and more distinct; aedeagal shaft in lateral view with subapical lateral teeth and upturned sharpened

apex, and without accessory lateral processes; female seventh sternum with posterior margin excavated on middle between posterior sharpened produced teeth and with a prominent median tooth produced from bottom of excavation.

Genitalia: Female seventh sternum about half as long as wide, lateral margins slightly converging from base to roundly produced posterior lateral angles, posterior margin rather convex, and sharply excavated on its middle to width of third sternum length, excavation with a median sharp tooth almost reaching acute excavation corners. Male in lateral view: Pygofer nearly quadrate with a long dorsally curving hook from lower posterior corner, hook length almost as long as pygofer width. Aedeagal base dorsoposteriorly inclined, its length about three fifths aedeagal length, its lower marginal half curving anteriorly along preatrium to articulation; aedeagal shaft stout, continuous dorsoposteriorly, with preatrial portion to sharpened upturned apex, a pair of small subapical teeth anterior to gonopore. In dorsal view: Aedeagus wider at base than along shaft, apex ovate with very small teeth at margin around gonopore; apodeme as paired lateral teeth. Connective Y-shaped; shaft expanded at articulation, its length about one third arm length.

Types: Unfortunately burned.

Material studied: (Missouri) Atherton, June 11, Noel, July 4; (Kansas) Franklin County, June 8, Doniphan County, August 22, Anderson County, October 24; (Alabama) Marion Junction, July 16; (Texas) Shamrock, August 10, Palopinto County, July 14; (Arkansas) Scott County, August 23, Washington County, June 30; (Minnesota) Winona County, June 30, Ramsey County, July 21; (New York) Geneva, August 15; (Georgia) Prattsburg, July 25; (Virginia) Norfolk, September 4, Warrenton, May 14; (Mississippi) Agri. College, June 18, Port Gibson, July 22; (Oregon) Portland, August 12; (Colorado) Rocky Ford; (Utah) Vernal, August 18, Current Creek, June 28, Farmington, September 21; (Washington) Underwood, July 9; (Michigan) Ann Arbor, March 10, Livingston County, June 20, Aug. 14; (Oklahoma) Grove, May 16, Comanche County, June 6; (Wisconsin) East Troy, August 10; (Georgia) Griffin, August 12; (Connecticut) Storrs, August 9; (Pennsylvania) Shade Gap, August 22; (Tennessee) Elkton, July 5; (Illinois) Tinsley Park, July 13; (Maryland) Plummer's Id., August 25, Baltimore, October; (Ohio) Mercer County, June 22; (Iowa) Moulton, September 2; (Nebraska) Hastings, June; (Ontario) Vineland, August.

Notes: Range, wide across the entire United States. A very com-

mon species. A meadow species of the Northern states (DeLong 1926).

74. *Paraphlepsius altus* (Osborn and Ball)

Phlepsius altus Osborn and Ball, Proc. Iowa Acad. Sci., vol. 4, 1897, p. 228.

Resembling *pusillus* in body form and coloration but more robust, with depressed crown, and darker in coloration; aedeagal shaft in lateral view dorsoposteriorly directed, tapering, with short dorsal median projection on its middle; female seventh sternum with broad posterior truncate margin between the two posterior lateral angles strongly produced, a median notch on margin.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins converging from base, posterior lateral angles strongly produced, posterior margin truncate with a median narrow notch. Male in lateral view: Pygofer somewhat triangular, upper margin angularly rounding above and sloping downward posteriorly to posterior angle from which rises a dorsal stout spine, spine about as long as half pygofer width, greatest width of pygofer about half its length. Aedeagal base dorsoposteriorly inclined, its length about one third aedeagal length, its lower margin concave, preatrium short; aedeagal shaft with basal depth about equal to base length, directed obliquely dorsad and tapering to a slender horizontal apical fourth, pair of retrorse teeth at anterior edge of dorsal horizontal plate on apical fourth; slender dorsal process about half base length arises from middle to shaft. In dorsal view: Aedeagus slightly wider basally, shaft stout, parallel-sided, a pair lateral teeth subapically; lateral apodemal horns stout and prominent. Connective Y-shaped with arms slightly converging apically; shaft length one fourth arm length.

Types: Lectotype male, Ames, Ia., August 11, 1896, designated, by P. W. Oman (1946) in Iowa State College Entomological Collections. Syntype male and syntype females, Ames, Ia., August 8, 1896, two syntype females, Ames, Ia., September 11, 1896, and one syntype female, Ames, Ia., August 4, 1896, Herbert Osborn, in Iowa State College Entomological Collections. One female syntype and two male syntypes, Ames, Ia., August 4, 1896, and three female syntypes and two male syntypes, Ames, Ia., August 11, 1896, Herbert Osborn, in Ohio State University Entomological Collections. Types studied.

Material studied: (Wisconsin) Lone Rock; (Minnesota) Battle Lake, Jordan; (Iowa) Little Rock, Spt. Lake, Ocheydan Mound, July 23; (South Dakota) Watertown, Brookings; (Nebraska) Cam-

bridge, August, Glen Sioux County, West Point; (Missouri) Diggins; (Kansas) Republic County, July 11, Cheyenne County, July 1, Douglas County, Greenwood County, Ottawa County, Decatur County, Ellsworth County, Cherokee County, September 2, Norton County, Clay County, Scott County, Jewell County, Wichita County, Pottawatomie County, Delphos, Riley County, Onaga, Sheridan; (Colorado) Wray, Julesburg.

Notes: Range, across western plains. DeLong (1926) designates it as a short-grass species of the western plains. "Buffalo grass" was written on a Kansas locality label. Found in moist habitats (DeLong 1948). By mistake *P. mimus* was placed in synonomy under *P. altus* in the Van Duzee Catalog (Ball 1927).

75. *Paraphlepsius fulvidorsum* (Fitch)

Jassus fulvidorsum Fitch, Homop. New York Cab., 1851, p. 62.

Resembling *eburneolus* in body form and coloration but with crown more produced and anterior part of body not so distinctly contrasted in color from that of elytra; aedeagal shaft in lateral view lobelike with a subapical ventral projection; female seventh sternum with produced narrow pair of median lobes, posterior lateral angles near median lobes by posterior converging of lateral border.

Genitalia: Female seventh sternum about five eighths as long as wide, lateral margins slightly converging and concave on basal two thirds, strongly converging on posterior third to slightly produced lateral angles, middle two thirds produced rather strongly into two acute lobes separated by a V-shaped notch. Male in lateral view: Pygofer somewhat triangular with dorsally curved spinelike hook from the posterior apex. Aedeagal base dorsoposteriorly inclined, its length about half aedeagal length, concave, with lower marginal half curving anteriorly along preatrium to articulation; aedeagal shaft rather lobelike, short, with a ventral pair of sharp projections about as long as width of base at this point. In dorsal view: Aedeagus expanded at posterior border of base; shaft short, tapering to bifid apex, ventral spinelike processes curved laterally, connective Y-shaped, arms converging anteriorly; shaft broad, about one fourth as long as the arm.

Types: Location of depository unknown.

Material studied: (New Hampshire) Boscawen, August 12; (Connecticut) New Haven, August 23; (Maryland) Plummer's Island, August 25, Beltsville, August 25; (Tennessee) Clarksville, July 14; (Virginia) Mt. Lake, September 12; (Kentucky) Cadiz, June 30;

(Wisconsin) Gillette, August 26; (Minnesota) Itasca Park, August 11.

Notes: Range, in states along Mississippi River Valley and eastward. Found in woodland on herbaceous plants of the heath association where *Smilax* and *Vagineria* are found (DeLong 1926).

76. *Paraphlepsius tennessa* (DeLong)

Phlepsius tennessa DeLong, Tenn. State Board Ent. Bull., 17, 1916, p. 64.
Phlepsius similis Lathrop, Ohio Jour. Sci., vol. 17, 1917, p. 127.

Resembling *punctiscriptus* in body form and coloration but males larger and coloration darker with more irrorate markings and dark spots on apical costal margin; aedeagal shaft in lateral view a stout short upright form with ventral beak dorsoposteriorly, in dorsal view apex bifid into two laterally directed horns; female seventh sternum with median pair of lobes separated by indication of a deep incision and produced about even with moderate posterior lateral angles.

Genitalia: Female seventh sternum about half as long as wide, lateral margins roundly converging from base, posterior lateral angles moderately produced, middle third of posterior margin produced into an obtuse lobe with median notch, a dark anterior pigment line from notch apex suggesting a deep incision. Male in lateral view: Pygofer somewhat triangular, with posterior angle broadly rounded with a stout spinelike process arising from upper corner and directed anterodorsally along upper margin, its length about equal to length of posterior margin, greatest width of pygofer about three fifths its length. Aedeagal base S-shaped, shortest length about one third aedeagal length, its lower marginal half curving anteriorly along the preatrium to articulation; aedeagal shaft with basal width of about base length, posteriorly directed to about distance of two thirds aedeagal length, then curving abruptly dorsad to a truncate apex on level with apodemal apices; a pair of long tapering horns arise subapically on posterior margin of shaft. Male in dorsal view: Aedeagus broad, wider on proximal half than on apical half; apex truncate with long subapical horns widely diverging; lateral apodemal processes bluntly pointed.

Types: Cotypes, five female and three males, Bells, Tennessee, June 16, Colliersville, Tennessee, June 22, Lexington, June 25, Tullahoma, Tennessee, August 1, Clarksville, Tennessee, July 14, August 3, and Knoxville, Tennessee, September 15, D. M. DeLong. Types deposited in collection of Dr. D. M. DeLong and male and female, Clarksville, Tennessee, D. M. DeLong, deposited in the Ohio State University Entomological Collections.

Material studied: (New York) Babylon; (New Jersey) Riverton, New Brunswick; (Maryland) Bladn'sb'g, Annapolis, Plummer's Id., August 22; (D. C.) Washington; (North Carolina) Franklin, Raleigh, August 31; (Virginia) Arlington, Emporia, Vienna, Back Bay, Annandale, July 21, Woolwine, Sept. 1, Norfolk, August 29; (Georgia) Prattsburg, August 25, Savannah, Peach County, Okefenokee Swamp, Thomasville; (Florida) Branford, Sanford, June 4, LaBelle, Fern Park, Hilliard, Suwannee Springs, July 13, Fort Meade, August 13; (Ohio) Hocking County; (Tennessee) Hamilton County, Elkton, July 6, Magnolia, September 24, Clarksville, Knoxville, August 17; (Kentucky) Jellico, August 15, Cadiz, June 30; (Alabama) Elgin, July 6, Prattsville, Burnsville, Decatur; (Mississippi) Leland, September 15, Hamilton, Iuka, July 14, Vicksburg, June 18, Woodville; (Arkansas) Polk County, July 21, August 21, Scott County; (Louisiana) Baton Rouge, August 6, Beauregard County, August 16, Natchtochee County, Calcasieu County; (Texas) Harris County, August 13, Orange County, Bowie County.

Notes: Range, throughout the southern states to Texas and northward to Ohio. *P. similis* Lathrop is *P. tennessa* DeLong (Ball 1927). As to habitat, DeLong (1926) says it is a meadow species in the northern states.

77. *Paraphlepsius macullelus* (Osborn)

Phlepsius macullelus Osborn, Maine Agr. Expt. Stat., Bull. 238, 1915, p. 141.

Resembling *fuscipennis* in body form and coloration, but with darker vermiculate lines; aedeagal shaft in lateral view moderately broad and long, dorsoposteriorly directed, irregularly tapering to a rounded apex with a small ventral beak; male pygofer triangular with long straight dorsal spine originating at posterior angle; female seventh sternum with posterior lateral angles broadly rounded and strongly produced, middle posterior margin convex with a median notch.

Genitalia: Female seventh sternum slightly more than three fourths as long as wide, lateral margins rounded, posterior lateral angles strongly and roundly produced, posterior marginal middle half convex with a median notch. Male in lateral view: Pygofer somewhat triangular, upper margin roundly sloping posteroventrally to a short posterior margin from which arises a sharp straight dorsal tapering hook, its length about half pygofer greatest width, a small beak at lower posterior corner. Aedeagal base dorsoposteriorly directed, its length half aedeagal length, concave with lower marginal half curving anteriorly along preatrium to articulation, pre-

atrium broadly expanding as it curves upward continuous with shaft; aedeagal shaft with basal width of two-fifths base length posteriorly directed, tapering slightly to apex with a turned down short beak. In dorsal view: Aedeagus basally narrowest at articulation and along proximal half of base, roundly expanding to twice articulation width at upper base portion, then suddenly reducing in width at base of shaft which tapers roundly to slightly bifid apex. Connective Y-shaped, arms roundly spread; shaft broad and short, only one sixth arm length.

Types: Holotype male, Orono, Maine, August 5, 1913, deposited in Ohio State University Entomological Collections. Type studied.

Material studied: (New York) Wanakena, Cranberry Lake.

Notes: Range, in northeastern states. Dr. H. Osborn is reported to have collected this form on fine grasses in the bog associations (DeLong 1926).

78. *Paraphlepsius certus* (DeLong)

Phlepsius certus DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 44.

Resembling *cinereus* in body form and coloration but smaller, vertex rounded, and with irrorations more delicate and lighter in color; aedeagal shaft in lateral view with broad upright base, then reduced to moderately broad and slightly arching long posterior shaft to a truncate apex, with subapical pair of spines; male pygofer with a short ventral hook arising from posterior corner; female seventh sternum with rounded posterior lateral angles moderately produced about even with a pair of median lobes separated by a notch and deeper incision.

Genitalia: Female seventh sternum length about half as long as wide, lateral margins almost parallel, posterior lateral angles slightly produced, a median bifid lobe incised deeply on posterior margin. Male in lateral view: Pygofer somewhat rectangular, roundingly angulate above, upper posterior corner with a rather long dorsal spine, greatest width of pygofer about five eighths its length. Aedeagal base about upright, its length about half aedeagal length, its lower marginal third curving along the preatrium to articulation; aedeagal shaft stout, with basal width of about one third of base length, is posteriorly directed from near base middle, terminating in truncate apex near posterior margin of pygofer; short spines arise subapically and ventrally on shaft, their apices short of shaft apex. In dorsal view: Aedeagus slightly wider at base, shaft keeled dorsally and apical fourth narrowed and bifid; subapical spines about

parallel; lateral apodemal horns prominent. Connective Y-shaped; shaft broad, its length about one third arm length.

Types: Holotype male, Wingra Lake, Wisconsin, July 8, 1916, H. K. Harley, deposited in collection of Dr. D. M. DeLong. Type studied.

Material studied: (Mississippi) Holly Springs, September 17; (Iowa) Ames, August 7; (Kansas) Douglas County, June 21, Kiowa County, July 4, Medora.

Notes: Range, in central northern states, but specimens were taken in Kansas. Found in Wisconsin freshwater marshes (DeLong 1948).

79. *Paraphlepsius dentatus* (Baker)

Phlepsius dentatus Baker, Ent. News, vol. 9, 1898, p. 65.

Resembling *humidus* in body form and coloration but smaller, crown not as wide and color generally lighter; aedeagal shaft in lateral view broad at base, then reduced from above, posteriorly directed on proximal third, then tapering and curving dorsad to a sharpened apex; male pygofer with moderate dorsal spine arising from the posterian angle; female seventh sternum with median lobe notched at apex and strongly produced much beyond the short posterior lateral angles.

Genitalia: Female seventh sternum three-fifths as long as wide, lateral margins moderately converging from base, posterior lateral angles slightly produced, middle half of posterior margin very strongly produced. Male in lateral view: Pygofer somewhat rectangular, rounded above, a strong dorsal spine arises from posterior margin, its length about two thirds pygofer width, a small notch on posterior margin, greatest width of pygofer about two thirds its length. Aedeagal base dorsoposteriorly directed, its length almost half aedeagal length; aedeagal shaft with basal width about half base length, posteriorly directed on proximal third, then curving dorsally to a sharpened apex. In dorsal view: Aedeagus swollen on base portion, then gradually tapering to a bifid apex. Connective Y-shaped with arms converging anteriorly; shaft broad, its length about one third length of arm.

Types: Holotype male, Delta Railroad, Baltimore, Maryland, in the Uhler Collection deposited in the U. S. National Museum. Compared with type specimens studied.

Material studied: (Vermont) Springfield, August 22; (Connecticut) Storrs, August 3; (New York) Fredonia, July 21; (Virginia) Arlington, September 12, Woodbridge, August 28; (Maryland)

Plummer's Island, August 23; (Florida) Dunnellon, July 12; (Pennsylvania) Wilmerdins; (Ohio) Medina County, Malta, Columbus, Duncan, Rocking County, Barberton, August 11; (Indiana) Gary, June 24; (Illinois) Onarga, July 13; (Michigan) Cheboygan County, July 20; (Iowa) Ames; (Wisconsin) Alma Center, St. Croix Falls, Muskego, July 16; (Missouri) Webster Grove, Pineville, July 19; (Tennessee) Clarksville, July 8; (Kansas) Muscotah, June 28, Atchison County, July 10, Bourbon County, August 31.

Notes: Range, in northern states east of Rocky Mountains. This species was confused with the cotypes of *P. humidus* Van Duzee 1892.

80. *Paraphlepsius hemicolor* (Sanders and DeLong)

Phlepsius hemicolor Sanders and DeLong, Proc. Ent. Soc. Washington, vol. 25, 1923, p. 152.

Resembling *particolor* in body form and coloration but slightly smaller; aedeagal shaft in lateral view posteriorly directed on proximal third from the lower part of its wider upright base, then curving dorsad, slightly tapering to the posteriorly recurved long beak, bifid in dorsal view; male pygofer triangular with dorsal and ventral beaks arising from posterior angle; female seventh sternum with rounded posterior lateral angles similar to the pair of rounded and widely separated median lobes.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins converging from base, posterior lateral angles produced moderately, two median lobes on posterior middle third separated by a notch deeper than lateral concavities. Male in lateral view: Pygofer somewhat triangular, posterior angle widely rounded bearing rather long stout beaks at upper and lower margins, greatest width of pygofer about half its length. Aedeagal base nearly upright, shortest length about one third aedeagal length, concave below with lower third curving anteriorly along the preatrium to articulation; aedeagal shaft with basal width of about half base length, posteriorly directed on proximal third then curving upward uniformly and slightly diminishing to a rounded apex which curves abruptly ventrad into a pair of long tapering beaks. In dorsal view: Aedeagus widest at base, narrowing slightly along stout shaft to a bifid apex with retrorse beaks below; dorsolateral apodemes stout and blunt apically. Connective Y-shaped with arms roundly separated, their apices diverging; shaft broad, its length about third arm length.

Types: Cotypes, Brookings, N. D., September 8, 1920, H. C. Severin, in collection of Dr. D. M. DeLong.

Material studied: (Manitoba) Morris, August 10; (Kansas) Pottawatomie County.

Notes: Range, across central northern states extending into Canada.

81. *Paraphlepsius tigrinus* (Ball)

Phlepsius tigrinus Ball, Canadian Ent., vol. 41, 1909, p. 80.

Resembling *attractus* in body form and coloration but larger and with slight depression of crown, color much darker except for whitish scutellum at its posterior point, milky blotches across clavus and elytra; aedeagal shaft in lateral view posteriorly directed on proximal half from lower part of broader upright base, then tapering as it curves dorsad to the apex posteriorly recurved, apex bifid in dorsal view, with subapical short spines; male pygofer posteriorly rounded and continuous with a ventral beak; female seventh sternum with posterior lateral angles slightly and roundly produced, median lobe moderately produced with a small median notch and deeper incision.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins almost parallel, posterior lateral angles scarcely produced, bifid median lobe on posterior margin with notch continuous anteriorly with a short median incision. Male in lateral view: Pygofer nearly rectangular, roundly sloping margin on upper posterior corner, continuous below with closely appressed hook reaching to ventral margin, greatest width of pygofer about five eights its length. Aedeagal base nearly upright, its length about five twelfths aedeagal length, concave with lower marginal half curving along the preatrium to articulation; aedeagal shaft posteriorly directed from the basal lower half with a basal width of about one sixth aedeagal length, diminishing as it curves gradually dorsad to terminate above pygofer with a pair of ventrally directed slender processes, one-fourth as long as aedeagus; a pair of dorsally directed sharp spines arise subapically on posterior border of shaft. In dorsal view: Aedeagus wider at base than along apical half, apex deeply bifid; lateral apodemes prominent. Connective Y-shaped, with arms somewhat parallel, their apices converging subapically then turned out apically; shaft slightly less than arm length.

Type: Holotype female in collection of E. D. Ball deposited in U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (Pennsylvania) Charter Oak, Dauphin, New Bloomfield; (Ohio) Cantwell Cliffs, Old Man's Cave; (West Virginia) Warren County; (Minnesota) Lake Itasca, August 11, Bena, August 12, Willow River, August 7; (Wisconsin) Merrillan, Sparta, Warren, Grand Rapids, Kilbourn.

Notes: Range, in northern states east of the Rockies. D. M. DeLong (1926) states that Dr. Knull has collected this form from *Pinus strobus* in Alleghenies of Pennsylvania. Also DeLong (1926) has taken the form on *Pinus rigida* and *P. virginiana* and it may be found on pine seedlings among taller grasses.

82. *Paraphlepsius rossi* (DeLong)

Phlepsius rossi DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 43.

Resembling *particolor* in body form and coloration but with vertex of crown more rounded, the crown, pronotum and scutellum much lighter in color than elytra; aedeagal shaft in lateral view posteriorly directed on proximal half and tapering from a moderately wide base, then curving dorsad to sharpened apex, bifid in dorsal view; a pair of slender processes arising at middle of shaft and closely paralleling it to apex; female seventh sternum long with a large V-shaped excavation on middle of posterior margin.

Genitalia: Female seventh sternum about four fifths as long as wide, lateral margins slightly converging posteriorly from base, posterior margin with a large semicircular excavation on its middle between truncate posterior lateral angles. Male in lateral view: Pygofer triangular, dorsal margin sloping downward posteriorly to a short posterior margin, a ventral beak at lower posterior corner formed by a notch just anterior to beak, its greatest width of pygofer about half its length. Aedeagal base inclined posteriorly, shortest length about fourth aedeagal length, concave with its lower marginal half curving anterodorsally along the preatrium to articulation; aedeagal shaft with basal width of fifth aedeagal length, tapering as it is posteriorly directed to a distance of two thirds shortest aedeagal length, then curving dorsad at right angles terminating in apex with a pair of dorsally directed spinelike processes; paired pronglike processes arise on inner curvature of aedeagal right angle, closely appressed to shaft, their posteriorly directed apices near base of shaft apical processes. In dorsal view: Aedeagus laterally swollen on proximal and apical halves. Connective Y-shaped, with arms converging apically to pointed apices; shaft broad, its length about arm length.

Types: Holotype male and male paratype, Portland, Connecticut, July 24, 1921, B. H. Walden, deposited in collection of Dr. D. M. DeLong; female allotype and male paratypes, Herod, Illinois, August 4, 1934, H. H. Ross, C. O. Mohr, and D. M. DeLong, deposited in Illinois Natural History Survey Collection. Types studied.

Material studied: (Illinois) Roseville, Norris City, September 9; (Mississippi) Leland, September 15; (Arkansas) Polk County, August 21.

Notes: Occupying an area between the Rocky Mountains and the Alleghenies but possibly not in extreme north or south.

83. *Paraphlepsius palustris* (Sanders and DeLong)

Phlepsius palustris Sanders and DeLong, Proc. Ent. Soc. Washington, vol. 25, 1923, p. 153.

Resembling several species in part but distinct in body form and coloration, with wide head, very short crown, raised pronotum and lightly colored elytra; aedeagal shaft in lateral view slender, posteriorly directed from lower part of upright base but curving dorsally and tapering in a long rounded curve to apex with a pair of recurved taillike processes; female seventh sternum about quadrate with posterior margin truncate and slightly produced beyond posterior lateral angles, a small median notch at middle.

Genitalia: Female seventh sternum about three fourths as long as wide, lateral margins uniformly converging from base, posterior lateral angles only slightly produced, posterior margin truncate and slightly produced, with a small median V-shaped notch. Male in lateral view: Pygofer about rectangular, lower posterior corner margin rounding upward to a short beak on lower posterior marginal third, and continuing posterodorsally to an upper posterior acute corner, greatest width of pygofer about half its length. Aedeagal base, anteriorly inclined, its length about three eighths aedeagal length, concave on lower margin, preatrium scarcely existent; aedeagal shaft slender, departing posteriorly from ventral part of base curving dorsally and anteriorly to terminate near pygofer in a pair of slender recurved tails. In dorsal view: Aedeagus widest at base, tapering to apex; basal apodeme narrowing anteriorly to bifid apex. Connective Y-shaped with arms reduced apically; shaft length about one half arm length, expanded apically.

Types: Cotype female, LaBelle, Florida, April 18, 1921, D. M. DeLong, cotype male, LaBelle, Fla., April 19, 1921, two cotype males, same locality, April 21, 1921, D. M. DeLong, deposited in collection of Dr. D. M. DeLong and in Ohio State University Entomological Collections. Types studied.

Material studied: (Georgia) Adel, August 11; (Mississippi) Orange Grove, July 10; (Alabama) Brewton, June 7.

Notes: DeLong (1926) states that they were swept from seedlings of *Pinus palustris* growing with a sedge *Juncus megacephalus* as well as from larger pines. This form is somewhat similar in body form and male genitalia to the species *Remadosus magnus* in spite of its being placed in another genus.

84. *Paraphlepsius lippulus* (Ball)

Phlepsius lippulus Ball, Canadian Ent., vol. 33, 1903, p. 227.
Phlepsius fulviceps Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923, p. 333.

Resembling *strobi* in body form and coloration but smaller with two whitish transverse bands across elytra and reticulations darker; aedeagal shaft in lateral view with proximal portion more parallel to upright base; male pygofer with dorsoposterior angle acute and curved dorsad; female seventh sternum with median lobe of posterior margin moderately narrow and scarcely produced beyond posterior lateral angles.

Male much smaller than female, more distinctly colored and apex of vertex less angulate and foliaceous than in female.

Genitalia: Female seventh sternum about two thirds as long as wide, lateral margins slightly converging from base, posterior lateral angles very slightly produced, a median obtuse lobe slightly produced on posterior margin. Male in lateral view: Pygofer somewhat rectangular, posterior third of upper margin sloping downward then curving posteriorly to the projected upper posterior corner, greatest width of pygofer almost half its length. Aedeagal base upright, its length about equal to aedeagal length; aedeagal shaft posteriorly directed from lower basal third a distance of half aedeagal length, then curves abruptly dorsad, slightly tapering to near upper margin of pygofer where it curves anteriorly to an asymmetrical apex with two long anteroventrally directed slender processes. In dorsal view: Aedeagus with wide rounded base, three times width of diminished upright shaft, gonopore opening on left side of base of apical processes. Connective Y-shaped with stout arms, their apices turned outward; shaft slender but expanding at apex.

Types: Lectotype female, Biscayne Bay, Florida, Annie T. Slosson, here designated, and one syntype, same locality and collector, in collection of E. D. Ball deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (North Carolina) Southport; (Georgia) Okefe-

nokee Swamp, July 25; (Florida) Cleveland, LaBelle, Bradenton, March 6, West Palm Beach, Edgewater, Yankeetown, Ocala, Cocoa Beach, Daytona, Child, Morrison Field, November 2, Fort Myers, Parish, July 9, Hilliard, August 19, Sanford; (Mississippi) Fulton, Gulfport, Hurley, Meridian, July 17; (Louisiana) Covington, June 23.

Notes: Range, in Florida and other southern states. Dr. DeLong (1926) says it is a southern species living mostly on *Pinus palustris*. *P. fulviceps* Osborn and Lathrop is *P. lippulus* Ball (Ball 1927).

85. *Paraphlepsius strobi* (Fitch)

Bythoscopus strobi Fitch, Ann. Rpt. State Cab. Nat. Hist. (New York), vol. 4, 1851, p. 58.
Phlepsius uhleri Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 67.
Phlepsius franconianus Ball, Canadian Ent., vol. 35, 1903, p. 228.

Resembling *lippulus* in body form and coloration but larger and with three whitish transverse bands across elytra and general coloration reddish brown; aedeagal shaft in lateral view curving roundly to apex, apical portion less parallel with upright base; male pygofer rounded on upper posterior corner; female seventh sternum with small posterior lateral angles scarcely produced, wide posterior margin roundly convex with a slight median notch.

Genitalia: Female seventh sternum about five eighths as long as wide, lateral margins rounded, posterior lateral angles only slightly produced, posterior margin produced moderately at middle beyond lateral angles. Male in lateral view: Pygofer somewhat rectangular, rounded above and somewhat narrowed to a rounded apex posteriorly, greatest width about half its length. Aedeagal base about upright, its length about half aedeagal length, preatrium absent, aedeagal shaft posteroventrally directed from lower basal half, rapidly narrowing on proximal fourth, then curving dorsad to an asymmetrical apex with pair of slender processes. In dorsal view: Aedeagus widest basally, tapering to apex of shaft. Connective Y-shaped, with arms roundly spread; shaft about equal to arm length.

Types: Depository unknown. Holotype male of *uhleri* deposited in Iowa State College Entomological Collections. The *uhleri* type studied.

Material studied: (New York) West Point, June 7, Salem, June 27; (Mississippi) A. and M. College, Fulton, July 14.

Notes: Range, in eastern states. *P. franconiana* has been collected from white pine.

86. *Paraphlepsius spinosus* sp. nov.

Resembling *Paraphlepsius supinus* (DeLong) but with uniform coloration, male aedeagus with apodemal structures straight and with a pair of subapical dorsal processes. Length, male 4.5 mm., female 5.5 mm.

Structure: Crown rather wide, anterior and posterior margins nearly parallel in male, slightly longer at middle in female, disc flat, angulate with front. Clypeus wedge-shaped, its basal width about three fourths its length. Clypellus constricted at base, gradually widened toward apex. Pronotum with anterior margin roundly extended forward between eyes, slightly concave posteriorly. Elytra closely compressed near apex.

Color: Dorsum marked rather evenly with light brown vermiculate lines and irrorations. Crown strongly embrowned, except for yellowish margin. Clypeus evenly covered with brownish coloration, with many yellowish spots and a few lateral arcs on apical half. Clypellus with two spots at base. Pronotum rather solid brown. Elytra with milky white, irrorations in cells.

Genitalia: Female seventh sternum about half as long as wide, lateral margins nearly parallel, posterior lateral angles very slightly produced, posterior margin slightly concave with indication of a pair of median lobes. Male valve triangular. Plates broadest basally, narrowing to apex, more constricted on outer half, apex rounded. Male in lateral view: Pygofer somewhat rectangular, narrowing posteriorly as it curves downward, then dorsad, to a rather acute apex. Aedeagal base dorsoposteriorly directed, its length about four-ninths aedeagal length, strongly concave below with margin curving anteriorly along a short preatrium to articulation; aedeagal shaft with basal width of half base length, posteriorly directed and tapering as it curves gradually upward to an apex with pair of recurved processes; a pair of subapical spines arise from ventral edge of shaft and directed dorsally. In dorsal view: Aedeagus with base rounded on sides and about twice wider than shaft. Connective Y-shaped, with arms converging anteriorly; shaft short and broad, its length about one fifth arm length.

Types: Holotype male and allotype female, Okefenokee Swamp, Georgia, July 25, 1939, R. H. Beamer. Deposited in the Snow Entomological Collections, University of Kansas.

Material studied: Only type material.

Notes: Range, known only for the Georgia swamp area.

87. *Paraphlepsius supinus* (DeLong)

Phlepsius supinus DeLong, Ohio Jour. Sci., vol. 38, 1938, p. 217.

Resembling *spinosus* in body form and coloration but slightly smaller in female and elytra darker; aedeagal shaft in lateral view posteriorly directed and curving upward to apex with recurved posterior hook, without subapical spines.

Genitalia: Female not known to date. In lateral view: Pygofer irregularly rectangular, contracted posteriorly by upper posterior marginal half sloping ventrad and posteriorly to a rather acute upper posterior corner, lower corner rounded. Aedeagal base upright in part, length about half aedeagal length, angularly and concavely V-shaped, lower marginal third curving anteriorly and upward along the preatrium to articulation, preatrium continuous in line with posterior shaft, upper two thirds of base as anterior border of narrow apodemal process which apically curves posteriorly and ventrally as a hook; aedeagal shaft with basal width of one fourth base length is directed rather dorsoposteriorly to apex with a ventrally recurved pair of hook processes. In dorsal view: Aedeagus widest at articulation, gradually narrowing to strongly bifid apex with processes curled outward and anteriorly. Connective shaft Y-shaped with arms extremely and roundly separated; shaft very broad and short, only one-fifth arm length.

Types: Holotype male, Battle Point, Virginia, June 22, 1918, J. G. Sanders, deposited in collection of Dr. D. M. DeLong.

Material studied: Only type material.

Notes: Range not known, but type locality indicates the species to be an Atlantic coast form.

88. *Paraphlepsius avicephalus* sp. nov.

Resembling *Paraphlepsius slossonae* (Ball) but banding more distinct, posterior border of pronotum white, male pygofer in lateral view with an avicephaliform projection posteriorly, median posterior lobes of female seventh sternum not strongly produced. Length male 5.5 mm., female 6.5 mm.

Structure: Crown rather wide, depressed, anterior and posterior margins almost parallel in male but longer on middle than next to eye in female, angulate with front. Clypeus wedge-shaped, with basal width about three fourths its length. Clypellus rectangular, and slightly narrower at base than apex. Pronotum evenly convex, rounding anteriorly. Elytra compressed apically.

Color: Dorsum with background of milky white, marked with

light brown irrorations and blotches. Crown with irregular blotches. Clypeus marked with many yellow spots. Clypellus yellowish with few brown flecks. Pronotum with two transverse brown bands. Elytra with brownish flecks or irrorations in cells, three light transverse bands across wings.

Genitalia: Female seventh sternum about one half as long as wide, lateral margin slightly converging from base, posterior lateral angles slightly produced, median lobes moderately produced beyond lateral angles. Male valves roundly triangular. Plates widest on basal third, narrowing laterally on middle and along a slender apical half, apices rounded. Male in lateral view: Pygofer somewhat rectangular, rounded posteriorly with an avicephaliform projection on posterior margin. Aedeagal base inclined dorsoposteriorly, its length one third aedeagal length, preatrium scarcely present; aedeagal shaft posteriorly directed, rapidly narrowed, then curves dorsally and anteriorly to an asymmetrical apex with a single slender process. In dorsal view: Aedeagal base ovate and wider than tapering shaft. Connective Y-shaped, with arms converging subapically, then curved outward apically, shaft slender, its length about equal to arm length.

Types: Holotype male, allotype female, three male paratypes, Morrison Field, Florida, Nov. 2, 1943, D. E. Hardy. Other paratypes: Two males from locality above September 3, 1942, same collector; three males and one female, Sanford, Florida, July 28, 1948, H. W. Crowder; one male, Sanford, Florida, September 6, 1928, E. D. Ball; one male, Sanford, Florida, July 31, 1933, C. O. Bare; one male, Sanford, Florida, July 28, 1948; two males, Yankeetown, Florida, July 17, 1934; two males, Homestead, Florida; one male, Plant City, Florida, July 14, 1939, P. W. Oman. Holotype, allotype, and paratypes deposited in Snow Entomological Collections, University of Kansas; paratype in U. S. National Museum.

Material studied: (Florida) Cocoanut Grove, August 9, Homestead, August 19, November 23.

Notes: Range, in Florida.

89. *Paraphlepsius punctiscriptus* (Van Duzee)

Phlepsius punctiscriptus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 75.

Resembling *slossonae* in body form and coloration but usually larger and with more uniform light coloration with less banding; male pygofer in lateral view with upper half of posterior margin slightly and roundly concave and a triangular notch with small open-

ing on lower half; female seventh sternum with median posterior lobes separated by a large notch and produced beyond moderately rounded posterior lateral angles.

Genitalia: Female seventh sternum about five eighths as long as wide, lateral margins about parallel, posterior lateral angles slightly produced, a median strongly produced lobe with a deep notch on posterior margin. Male in lateral view: Pygofer, short, rectangular to quadrangular, upper margin rounded convexly and posterior margin with a slight concavity just above a "bird's bill" which forms a triangulate notch by its approaching the apex of a short posteriorly directed point from lower posterior corner, greatest width of pygofer about five sevenths length. Aedeagal base, inclined dorsoposteriorly, its length about five eighths aedeagal length, preatrium expanding dorsally from articulation forming a "sickle handle" to shaft proper; aedeagal shaft posteriorly directed from upper base portion, with basal depth of about half base length, then tapering as it curves dorsally and anteriorly "sickle-like" to a slender apex. In dorsal view: Aedeagus widest at base, gradually tapering to apex, asymmetrical in that duct portion runs along left side of shaft to its apical third; short apodemal horns anteriorly projected. Connective Y-shaped; shaft rather slender, expanded apically, its length about arm length.

Types: Lectotype [female?] Texas, designated by P. W. Oman (1946) in Iowa State College Entomological Collections.

Material studied: (South Dakota) Hot Springs; (Kansas) Riley County, Hodgeman County, July 17, Scott County, June 20; (Missouri) Noll, July; (Mississippi) Shuqulak, July 16; (Louisiana) Nachitocha, August 16; Camp Polk, May, Covington, June 23.

Notes: In genital structure this form appears to be related to *P. slossoni* and the other true banded forms.

90. *Paraphlepsius slossonae* (Ball)

Phlepsius slossonae Ball, Canadian Ent., vol. 37, 1905, p. 209.

Resembling *tullahoma* in body form and coloration but lighter in color and with transverse bands on elytra; male pygofer in lateral view with shallow rectangular notch on upper half of posterior border and a notch twice wider than in *tullahoma* on lower half of posterior margin; female seventh sternum with posterior margin irregularly truncate except for pair of slightly produced median narrow lobes separated by a small V-shaped notch.

Genitalia: Female seventh sternum almost five ninths as long as wide, lateral margins slightly converging from base, posterior

lateral angles only slightly produced, posterior margin angularly produced on middle with rather distinct median notch. Male in lateral view: Pygofer hardly rectangular, greatest width of pygofer about half its length, upper margin rounding above, posterior margin distinct in having a deep square notch above the lower posterior corner, above with avicephaliform marginal shape. Aedeagal base inclined posteriorly, slightly concave, length less than half aedeagal length, its lower margin curving anteriorly along a short preatrium to articulation; aedeagal shaft posteriorly directed basally, basal depth about one third of length, gradually tapering as it turns dorsad and anteriorly in a long rounding curve, to a rather sharp apex. In dorsal view: Aedeagal shaft appears asymmetrical in that duct arises along right side of upturned portion of shaft, extending to about apical third of shaft. Connective, Y-shaped; its slender shaft about arm length.

Types: Holotype female, Biscayne Bay, Florida, Annie T. Slosson, in collection of E. D. Ball deposited in U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (Georgia) Prattsburg, July 25; (Florida) Cocoanut Grove, August 9, Ft. Myers, Jacksonville, Loughman, Yankeetown, July 31, Homestead, October 23; (Alabama) Prattsville, August 21; (Mississippi) Shuqulak, July 16; (Tennessee) Clarksville, November 2.

Notes: Range, in Florida and other southern states. *P. slossoni* of the South taken only from *Pinus caribea* (DeLong 1926).

91. *Paraphlepsius tullahomi* (DeLong)

Phlepsius tullahomi DeLong, Tennessee State Board Ent., Bull. 17, 5, 1916, p. 75.

Resembling *slossonae* in body form and coloration but darker; male pygofer in lateral view with a deep rounded notch on upper half of its posterior margin and a narrow notch half as wide as in *slossonae* on lower half of margin; female seventh sternum with narrow produced posterior lateral angles and convex posterior margin with pair of median narrow produced lobes.

Genitalia: Female seventh sternum five ninths as long as wide, lateral margins converging from base but more so on their posterior third, posterior lateral angles acutely produced, middle three fourths of posterior margin concave with medianly produced small lobes separated by a deep notch. Male in lateral view: Pygofer somewhat rectangular, posterior margin excavated by an upper deep squarelike notch and a lower narrow notch the upper margin

of which appears avicephaliform. Aedeagal base nearly upright, its length half aedeagal greatest length, posteriorly directed on proximal third curving dorsad, slightly tapering then curving strongly anterior to a tapered slender apical half. In dorsal view: Aedeagus widest at base tapering to apex, asymmetrical in that duct arises on right side of shaft posteriorly and terminates on apical third. Connective Y-shaped; shaft apically expanded, its length half longer than arm length.

Types: Holotype male, Tullahoma, Tennessee, August 3, 1915, D. M. DeLong, deposited in collection of Dr. D. M. DeLong. Type studied.

Material studied: (Ohio) Neotoma, Cantwell Cliffs, Hocking County; (South Carolina) Tryon; (Tennessee) Clarksville; (Louisiana) Covington, June 23.

Notes: Range, in Tennessee and adjacent states north and eastward. This form is one of the banded forms closely related to *slossonae* in structure of the genitalia.

92. *Paraphlepsius obvius* (Oman)

Phlepsius obvius Oman, Washington Acad. Sci. Jour., vol. 21, 1931, p. 435.

Resembling *emarginatus* in body form and coloration but slightly larger and darker; aedeagal shaft apical in lateral view short, oval with a small ventral beak; male pygofer hook acutely rounded at apex; plate short, truncate on apex with medially directed tooth on its apical margin; female seventh sternum short, posterior lateral angles well produced beyond a pair of small median lobes.

Genitalia: Female seventh sternum about half as long as wide, lateral margins slightly concave on middle, and converging posteriorly, posterior lateral angles strongly produced, posterior middle fourth rather squarely produced with a median notch. Male in lateral view: Pygofer somewhat triangular, upper anterior marginal third parallel to lower margin, posterior two thirds slopes downward to posterior angle with a stout ventrally directed process from middle of slope and on inner surface almost reaching lower margin then curving posteriorly to its blunt apex slightly beyond angle, greatest width of pygofer about seven tenths its length. Aedeagal base nearly upright, length about half aedeagal length, concave below with lower marginal third curving anteriorly along the preatrium to articulation, preatrium very long, curving upward to shaft proper; aedeagal shaft rather short with basal depth of third base length posteriorly directed from upper basal third, slightly enlarging on apical half with a short ventral beak. In dorsal view: Aede-

agus basally wide on proximal two thirds, then narrowing to a bifid apex, keeled on middle; lateral apodemes as short spurs. Connective Y-shaped with arms widely separated in rounded curves; shaft broad, its length only about one sixth arm length.

Types: Holotype male, allotype female, and one female paratype, Kingsville, Texas, Clyde T. Reed, deposited in U. S. National Museum. Specimens compared to types by Dr. P. W. Oman.

Material studied: (Texas) Kingsville, San Juan.

Notes: Range, limited to Texas and near-by areas.

93. *Paraphlepsius emarginatus* sp. nov.

Resembling *Paraphlepsius obvius* (Oman) but slightly smaller, lighter in coloration with indication of two whitish transverse bands across the elytra, pygofer hooks sharp apically, aedeagal shaft ovate portion rather slender, tooth on plate within capsule subapical and anteriorly directed. Length, male 6 mm., female 6.5 mm.

Structure: Crown almost flat, half longer on middle than next to eye, subangulate with front. Clypeus with base seven ninths its length, lateral margins rounded, rather evenly convex. Clypellus rectangular, narrower at base, gradually widening to apex. Pronotum broadly rounded and advanced far anteriorly between eyes, slightly concave behind. Elytra laterally compressed on apical portion.

Color: Crown, pronotum, and scutellum yellowish, with irrorate brown markings irregular near eye, with white spot at posterior border of crown, ramose markings on posterior half of pronotum, two pairs of dark spots on lateral border of scutellum. Clypeus evenly marked with brown, dotted with yellow. Clypellus with irrorate brown marks on ventral half and a few at base. Elytra milky white with sparsely placed vermiculate and irrorate brown markings, indication of two light bands across elytra, light spots along commissural line.

Genitalia: Female seventh sternum five sevenths as long as wide, lateral margins converging from base, concave at middle, posterior lateral angles moderately produced with a truncate posterior margin between and interrupted by a median notch and deep incision. Male valve sinuously triangular. Plates widest basally, narrowing uniformly to truncate apices, a subapical blunt tooth directed anteriorly. Male in lateral view: Pygofer somewhat rectangular, narrowing posteriorly, lower posterior corner rounded; pygofer hook within upper margin curved in large arc, ventrally, posteriorly, and dorsally, to pointed apex. Aedeagal base nearly upright, its length

about half aedeagal length, preatrium long, curving upward to shaft; aedeagal shaft with basal width of one fourth base length, posteriorly directed, apical half with ovate shape, with apical beak turned ventrad. In dorsal view: Aedeagus widest just posterior to articulation, tapering to apex, apical half keeled above. Connective Y-shaped with arms roundly spread; shaft broad, its length about two fifths arm length.

Types: Holotype male, Hudson, Florida, July 13, 1939, P. W. Oman, allotype female, same locality and time, R. H. Beamer, and one male paratype, Orange County, Florida, June 22, 1929, W. A. Hiers. Holotype, allotype and paratypes deposited in Snow Entomological Collections, University of Kansas; paratype in the U. S. National Museum.

Material studied: Only type material.

Notes: Range, in Florida. This species adds a new form to the *maculosus* complex.

94. *Paraphlepsius maculosus* (Osborn)

Phlepsius maculatus Osborn, Ohio Nat., vol. 5, 1905, p. 274, (name *maculatus* preoccupied).
Phlepsius maculosus (Osborn) Ann. Ent. Soc.. Amer., vol. 16, 1923, p. 319.

Resembling *pallidus* in body form and coloration but slightly smaller and darker with dark mottling on elytra and pronotum; male plates shorter and contracted apically on median border; male pygofer in lateral view without a hook on dorsal border and the upper posterior corner projected dorsally; female seventh sternum with small moderately produced posterior lateral angles, a broad posterior margin convexly produced beyond lateral angles and with a large V-shaped notch at middle.

Genitalia: Female seventh sternum three fourths as long as wide, lateral margin converging on basal third, then nearly parallel, posterior lateral angles small and moderately produced, median to which the posterior margin is strongly produced into two broad more or less truncate diverging lobes separated by a large V-shaped notch. Male in lateral view: Pygofer somewhat rectangular, upper marginal anterior half rounded above, but posterior half slightly concave with a blunt dorsal point at upper posterior corner, a sharp spine arising on inside of upper marginal middle and directed slightly downward, greatest width of pygofer anteriorly about eight elevenths its length. Aedeagal base nearly upright, its shortest length almost half aedeagal length, concave below with lower marginal third curving anteriorly along the preatrium to articulation, preatrium curving upward expandingly to the shaft proper; aede-

agal shaft with basal width of third base length, dorsoposteriorly directed, roundly deepening on apical two thirds to a short apical beak. In dorsal view: Aedeagus widest at base of shaft, slightly narrowing to the bifid apex. Connective Y-shaped; shaft broad, its length one third arm length.

Types: Holotype female, Sandusky, Ohio, July 30, 1904, Herbert Osborn, and allotype male, Carns, Nebraska, July 25, 1902, both in Herbert Osborn's Collection deposited in Ohio State University Entomological Collections.

Material studied: New York Springs on Long Island, New York.

Notes: Range, in the northeastern states.

95. *Phlepsius pallidus* (Van Duzee)

Phlepsius pallidus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 69.

Resembling *divergens* in body form and coloration but slightly larger and coloration paler; male pygofer with short posteriorly directed hook arising from inner margin of dorsal border, length of posterior border of pygofer about half length of anterior border; female seventh sternum with posterior lateral angles small, a broad posterior margin strongly and roundly convex with a small median notch.

Genitalia: Female seventh sternum about two thirds as long as wide, lateral margins converging from base, length only about five sevenths sternum length, posterior angles small and slightly produced, posterior margin extremely convex and produced beyond lateral angles with a median deep notch. Male in lateral view: Pygofer nearly rectangular, depth gradually diminishing posteriorly to half its greatest depth, greatest width about five sixths length. A short spine arises slightly behind upper marginal middle on inner surface curving posteriorly. Aedeagal base nearly upright, length about one half aedeagal length; preatrium deep, curving upward to shaft proper; aedeagal shaft with basal width of third base length posteriorly directed, curving upward to shaft proper; aedeagal shaft with base width of one third base length, posteriorly directed, curving upward on proximal third into a swollen portion which diminishes rather abruptly to a sharp apex. In dorsal view: Aedeagus widest basally but suddenly reduced to a stout parallel-sided shaft, apex abruptly narrowed and bifid; lateral apodemes broad with blunt apex.

Types: Lectotype [female?] Texas, Aaron, Herbert Osborn, designated by P. W. Oman (1946) in Iowa State College Entomological Collections.

Material studied: (Kansas) Medora; (Texas) Jefferson, June 21; (Georgia) Decatur County, July 23.

Notes: Range, in Kansas and southward into Texas.

96. *Phlepsius divergens* (Oman)

Phlepsius divergens Oman, Washington Acad. Sci. Jour., vol. 21, 1931, p. 435.

Resembling *pallidus* in body form and coloration but slightly smaller and with darker fuscous irrorations; male pygofer in lateral view with a large hook arising on inner border of the dorsal margin directed medially on proximal portion then curving posteriorly to its sharp apex; length of posterior margin of pygofer at least two thirds length of anterior margin; female seventh sternum similar to that of *pallidus* but dark coloration over plate divided at middle by a triangular light area, widest anteriorly.

Genitalia: Female seventh sternum about half as long as wide, lateral margins slightly converging, posterior lateral angles moderately produced, posterior margin strongly produced into a pair of large lobes separated by a V-shaped notch, apices of lobes obliquely truncate. Male in lateral view: Pygofer almost quadrate, slightly narrower posteriorly, with produced round posterior corners; a stout hook curving inward slightly dorsad and posteriorly, to a sharp apex, arising from middle of upper margin. Aedeagal base about upright with lower third curving anteriorly to articulation, its length about half aedeagal length; aedeagal shaft, with basal width of one third base length, is dorsoposteriorly directed, expanding on apical two thirds into an ovate form, with an apical beak. In dorsal view: Aedeagus widest near apodemes, tapering to bifid apex, keeled above on apical two thirds.

Types: Holotype male, Forestburg, Texas, June, 1928, deposited in the U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (Kansas) Medora, July 2, 1927; (Texas) Romney, June 30, Victoria County, August 9, Sarita, December 2.

Notes: Range, in south central states.

97. *Paraphlepsius operculatus* (Ball)

Phlepsius operculatus Ball, Canadian Ent., vol. 59, 1927, p. 265.

Resembling *latifrons* in body form and coloration but smaller and with darker irrorations; male pygofer in lateral view with posterior margin continuous above with a sharp dorsal beak and below with a ventral beak, a sharp point at middle of posterior margin; female

seventh sternum long with the posterior lateral angles produced as acute points and continuous medianly with a large V-shaped excavation over half way to base.

Genitalia: Female seventh sternum about two thirds as long as wide, lateral margins sinuately converging from base, posterior lateral angles acutely produced at lateral margins, their inner margins bordering a large V-shaped excavation narrowed anteriorly to an acute notch. Male in lateral view: Pygofer somewhat rectangular, anterior margin slopes anteriorly upward, upper posterior marginal half curving ventrally to a stout dorsal beak at upper posterior corner, posterior margin convex with lateral beak at its middle and continuous on lower half as margin of a ventral stout spine extending slightly below lower pygofer margin, greatest width of pygofer almost half its length. Aedeagal base nearly upright, length about half longer than aedeagus, lower marginal half slightly curved along an upright preatrium to articulation; aedeagal shaft rather short with a "pump spout" shape, a basal posterior protuberance below shaft proper. In dorsal view: Aedeagus slightly swollen at middle, apex rounded; lateral basal apodemes long and tapering. Connective Y-shaped; arms very widely separated; shaft broad, its length about fourth arm length.

Types: Holotype female, and allotype male, Sanford, Florida, September 6, 1926, and paratypes Sanford and Daytona, Florida, in collection of E. D. Ball deposited in the U. S. National Museum. Female paratype, Sanford, Florida, July 8, 1926, E. D. Ball in Ohio State University Entomological Collections. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Georgia) Adel, August 11, Okefenokee Swamp, July 27; (Florida) Sanford, April 18, Hilliard, LaBelle, July 16, Ocala, August 17; (Alabama) Decatur, July 6; (Mississippi) Hamilton, July 15, Okolona, Meridian, August 14; (Kansas) Galena, October; (Tennessee) Clarksville, July 10.

Notes: Range, in Florida and across southern states to Mississippi. This species is very close to *P. latifrons* but differs distinctly in lack of dorsal pygofer spine.

98. *Paraphlepsius mimus* (Baker)

Phlepsius mimus Baker, Ent. News, vol. 9, 1898, p. 67.
Phlepsius cottoni Sanders and DeLong, Proc. Ent. Soc. Washington, vol. 24, 1922, p. 98.

Resembling *operculatus* in body form and coloration but head not so sloping, size smaller, and coloration darker; male plates with

lateral notch on lateral border by contraction of apical third; male pygofer in lateral view with a triangular plate arising on inside of lower margin; female seventh sternum with posterior margin truncate, except for slight rounded production of posterior lateral angles.

Genitalia: Female seventh sternum about half as long as wide, lateral margins converging abruptly on basal third, then sinuately converging to slightly produced posterior lateral angles, posterior margin almost truncate with only a slight concavity at middle. Male in dorsal view: Pygofer triangulate, upper margin angularly sloping downward posteriorly to an anteriorly projected short spine, upper margin of which slopes posteroventrally to a short ventral spine at lower posterior corner; a triangular chitinous piece arising from posterior two thirds of lower margin with one side of triangle along margin, greatest width of pygofer about three fifths length. Aedeagal base nearly upright, length about half aedeagal length, its lower fourth curves anteriorly along the preatrium to articulation; aedeagal shaft directed dorsoposteriorly with basal width of two-thirds base length, and terminating in an avicephaliform apex with beak ventral. In dorsal view: Aedeagus, quadrate on basal two thirds, then sharply narrowing to apex. Connective Y-shaped with arm apices turned outward; shaft very short with apparent shallow excavation apically.

Types: Holotype male, Odenton, Maryland, October 11, in the Uhler Collection deposited in the U. S. National Museum. Specimens compared with type by Dr. P. W. Oman.

Material studied: (Maryland) Plummer's Island, August 25; (North Carolina) Benson, August 9, Raleigh; (Georgia) Blackshear, Okefenokee Swamp, July 25, August 26; (Florida) LaBelle, July 16, Orange County, June 12, Hillsboro, Liberty County, Dunnellon, Deerfield, Branford, August 4, Zolfo Spring, Glades County, March 29, DeSoto County, Ft. Myers, August 11, New Smyrna, Jacksonville, Sanford, November 17, Orlando, Hilliard, Plant City; (Arkansas) Hope.

Notes: Range, in Florida along the South Atlantic coast. In Van Duzee catalog *P. mimus* Baker has been listed as a synonym of *altus.* Types of *P. mimus* were taken from a sandy region between Baltimore and Washington and others were taken from sandy areas in Florida (Ball 1927). *P. cottoni,* a synonym, occurs in *Cladium effusum,* sawgrass association in Florida Everglades (DeLong 1926).

99. *Paraphlepsius bifidus* (Sanders and DeLong)

Phlepsius bifidus Sanders and DeLong, Ann. Ent. Soc. Amer., vol. 10, 1917, p. 89.

Resembling *dentatus* in body form and coloration but body not so robust and with uniform darker coloration; aedeagal shaft in lateral view appearing as a "seal" body; male pygofer with posterior margin continuous above with a slender beak and below with a ventral beak; female seventh sternum with broad posterior lateral angles continuous medially with a deep V-shaped excavation about two thirds distance to base.

Genitalia: Female seventh sternum about three fourths as long as wide, lateral margins sinuately converging from base, posterior lateral angles broadly rounded, posterior margin with deep V-shaped notch two thirds distance to base. Male in lateral view: Pygofer somewhat rectangular, posterior half reduced to two thirds anterior depth from above, a dorsally directed spine at upper posterior corner, its posterior margin continuous below with a ventral spine arising at middle of posterior margin and extending to lower corner of pygofer, greatest width of pygofer about one third its length. Aedeagal base almost upright, its length about half aedeagal length, concave with its lower margin curving anteriorly along the preatrium to articulation; aedeagal shaft with basal width equalling base length, posteriorly directed on basal third then curving dorsad tapering to a posteriorly directed "seal head" apex. In dorsal view: Aedeagus widest basally narrowing to bifid apex, shaft dorsally keeled and apical third slightly swollen. Connective Y-shaped, shaft scarcely existent, consisting of mainly articulation points.

Types: Two female cotypes, Trout Lake, Wisconsin, September 7, 1916, and two male cotypes, Amery, Wisconsin, August 13, 1916, and Woodruff, Wisconsin, September 8, 1916, D. M. DeLong, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Canada) Ottawa, Newago; (New York) Sabael, Elka Park, Cranberry Lake, Wanakena, Greene County; (Manitoba) Deepdale, Swan River, August 2, Keld; (Saskatchewan) Pelly, August 2; (Michigan) Two Harbors, August 14, Itasca Park, Eveleth, Fairbanks.

Notes: Range, in northern states and Canada.

100. *Paraphlepsius turpiculus* (Ball)

Phlepsius turpiculus Ball, Canadian Ent., vol. 32, 1900, p. 200.

Resembling *continuus* in body form and coloration but slightly larger and coloration more irregular; male pygofer in lateral view

triangular with the spine-like process arising at middle of upper margin and extending posteriorly as a sinuous tapering process; female seventh sternum with posterior lateral angles roundly and strongly produced but their apices directed slightly toward a median line, border around median lobes darker in color.

Genitalia: Female seventh sternum slightly more than half as long as wide, lateral margins converging on their posterior third, posterior margin with obtuse median lobe with deep broad V-shaped notch, a dark pigment line running anteriorly from notch apex suggesting a deeper incision. Male in lateral view: Pygofer triangular, upper margin posteriorly sloping downward and continuous on posterior marginal sixth with a sinuate posteriorly directed spine reaching beyond pygofer to about even with plate apex. Aedegal base nearly upright, shortest length about half aedeagal length, concave with its lower marginal third curving anteriorly along preatrium to articulation; aedeagal shaft a posteriorly directed quadrate body, its basal width about two thirds aedeagal length. A ventral beak at lower posterior corner. In dorsal view: Aedeagus proximal two thirds wider than apical narrowed beak. Connective Y-shaped, shaft stout, expanding toward apex, its length about half arm length.

Types: Lectotype male, Fort Collins, Colorado, July 12, 1898, here designated; syntypes collected at Holly and Fort Collins, Colorado. Types in collection of E. D. Ball deposited in the U. S. National Museum. Pair from cotype series on hand for study.

Material studied: (Manitoba) Russel, Hartney; (Michigan) Muskegan County, Oceana County, July 20, Brevort, Cedar River, August 26, Machinac Island, Isle Royal, Big Stone County; (North Dakota) Tappen, July 23, Tokio; (South Dakota) Redfield; (Nebraska) Genoa, September 10, Stratton, July 14; (Mississippi) Meridian, Leland, Pasogoula; (Kansas) Sterling, Greenwood County, Ellsworth County, Labette County, Scott County, Hodgeman County, Eureka, Clark County, Douglas County, August 30, Meade County, Decatur County, Logan County, Neosho County, Liberal, June 13, Saline County, Dodge City, Wilson County, Leavenworth County, Wichita; (Texas) Victoria; (Colorado) Fort Collins, August 14, Akron.

Notes: Range, throughout the western plains and along the Mississippi River Valley, even as far north as Manitoba, Canada. Dr. Ball (1927) says this species was described from examples of the big broad pale form that occurs in meadows throughout the plains and the Mississippi Valley, and distinct from the smaller darker form in the salt marsh areas of the Atlantic Coast.

101. *Paraphlepsius abruptus* (DeLong)

Phlepsius abruptus DeLong, Lloydia, vol. 1, 1938, p. 238.

Resembling *fuscipennis* in body form and coloration but slightly larger and coloration lighter; male pygofer in lateral view triangular with pygofer spine arising on its posterior dorsal border and curving sharply ventrad over posterior border to end in a sharp apex about even with ventral border; female seventh sternum almost as long as wide, posterior lateral angles strongly and roundly produced considerably beyond the wide rounded pair of median lobes.

Genitalia: Female seventh sternum about seven eighths as long as wide, lateral margins nearly parallel but converging on their posterior third, posterior lateral angles strongly produced, posterior margin slightly convex on either side of a shallow median notch. Male in lateral view: Pygofer somewhat rectangular, dorsal margin sloping downward posteriorly to a short posterior margin, a pygofer spine from upper posterior corner bends abruptly ventrad along posterior margin to about even with lower margin, its greatest width about two thirds length. Aedeagal base inclined posteriorly, length about half aedeagal length, concave with lower two thirds curving anteriorly along preatrium to articulation; shaft quadrate in form with basal width about base length; a stout curved beak at its lower posterior corner. In dorsal view: Aedeagus widest at base, narrowing to apex, shaft keeled above before gonopore. Connective Y-shaped with arms converging and thickened apically; shaft slender, apically expanded, its length about half arm length.

Types: Holotype male and paratype male, Bells, Tennessee, June 16, 1915, D. M. DeLong, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Georgia) Tifton; (Florida) Hibernia, August, Jacksonville, August.

Notes: Range, in southeastern states where *P. fuscipennis* is found in salt marsh areas (Ball, 1927). Because of similarities with above phylogenetic relationships are evident. It seems also closely related to the Texas species *P.continuus* as well as *P. siclus* and *P. turpiculus.*

102. *Paraphlepsius continuus* DeLong

Phlepsius continuus DeLong, Lloydia, vol. 1, 1938, p. 239.

Resembling *fuscipennis* in body form and coloration but with vertex more rounded, slightly larger and with lighter coloration; male pygofer in lateral view triangular with spinelike process arising from posterior dorsal border and curving ventrad over posterior

margin and extending slightly beyond ventral pygofer margin, apex slightly curved posteriorly to its sharpened vertex; female seventh sternum with posterior lateral angles moderately produced scarcely beyond the widely separated median lobes.

Genitalia: Female seventh sternum about three fifths as long as wide, lateral margins converging slightly on their posterior third, posterior lateral angles rather strongly produced, a pair of median slightly produced lobes separated by a wide notch on posterior middle. Male in lateral view: Pygofer somewhat rectangular, upper margin sloping downward posteriorly to a spine arising on marginal posterior fifth and curving ventrally along posterior margin to slightly below lower margin, greatest width of pygofer about three fifths its length. Aedeagal base, rather posteriorly inclined, shortest length about two sevenths aedeagal length, extremely concave with lower marginal half curving anteriorly and dorsad along the preatrium to articulation; aedeagal shaft quadrate in form with basal width about twice shortest base length, a ventral beak at its lower posterior corner. In dorsal view: Aedeagus widest basally, sinuously narrowing to a blunt apex, keeled anterior to gonopore; lateral apodemes bluntly short. Connective Y-shaped; shaft slender, slightly expanded apically.

Types: Holotype male, allotype female, and male and female paratypes collected at Brownsville, Texas, May 1, 1925, J. N. Knull, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Mississippi) Port Gibson, July 22, Agric. College, Orange Grove, Harlington; (Louisiana) New Orleans, June 10, Calcasieu County, Creole, Caddo County, Beauregard County, August 15, Alexandria, Camp Polk, May; (Texas) Brazoria County, Colorado County, March 19, McAllen, December 30, Jackson County, Brownsville, Harris County, Galveston, May, Cameron County, August.

Notes: Range, in Texas and in adjacent states eastward and northward. It is close relative of *P. turpiculus* as well as the other fuscipennis-like forms.

103. *Paraphlepsius siclus* (DeLong)

Phlepsius siclus DeLong, Lloydia, vol. 1, 1938, p. 238.

Resembling *fuscipennis* in body form and coloration but with an oblique dark irregular marking on middle of elytra; male pygofer in lateral view triangular, with the spinelike process arising on the posterior dorsal margin, curving ventrad over posterior margin to considerably beyond the ventral margin of pygofer and plates as

well; female seventh sternum with lateral margins converging posteriorly, posterior lateral angles narrowly produced beyond the median pair of lobes.

Genitalia: Female seventh sternum slightly more than half as long as wide, lateral margins rather strongly converging from base, posterior lateral angles strongly and acutely produced, posterior marginal third moderately produced into an obtuse lobe slightly notched. Male in lateral view: Pygofer nearly triangular, a stout tapering hook arising just behind middle of upper margin follows margin posteriorly on its basal half then curves ventrally anterior to posterior angle of pygofer, extending considerably below lower margin, greatest width of pygofer about three fifths its length. Aedeagal base, nearly upright, its length half aedeagal length, concave with marginal third curving anteriorly to articulation; aedeagal shaft quadrate with basal width of about base length, a ventral beak at lower posterior corner. In dorsal view: Aedeagus widest at base, narrowing to slightly bifid apex, keeled anterior to gonopore; apodemes not prominent. Connective Y-shaped; shaft short, apex widened, its length about one third arm length.

Types: Holotype male, allotype female, and male and female paratypes, St. Petersburg, Florida, March 16, Herbert Osborn. Type deposited in collection of Herbert Osborn deposited in Ohio State University Entomological Collections. Male and female paratypes, same locality, deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: (Florida) Ft. Myers, Ruskin, Tampa.

Notes: Range, in Florida. It is undoubtedly a close relative of *P. fuscipennis.*

104. *Paraphlepsius fuscipennis* (Van Duzee)

Phlepsius fuscipennis Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 70.
Phlepsius pusillus Osborn and Lathrop, Ann. Ent. Soc. Amer., vol. 16, 1923.

Resembling *siclus* in body form and coloration but coloration brownish, darker and with uniform irrorations; male pygofer in lateral view with spinelike process arising from posterior dorsal margin curving ventrad over posterior margin in a rather uniform curve tapering to its apex slightly beyond and posterior to the ventral margin; female seventh sternum with darker markings usually on border of median lobes.

Genitalia: Female seventh sternum about half as long as wide, lateral margins uniformly converging from base, posterior lateral angles moderately produced, middle of posterior margin with

rounding, median, obtuse, bifid lobe. Male in lateral view: Pygofer nearly triangular, upper posterior marginal half sloping downward and posteriorly continuous as outer margin of a long spinelike process arising on upper posterior marginal third and roundingly curving downward along short posterior margin to slightly beyond lower margin of pygofer, greatest width of pygofer about three fifths its length. Aedeagal base nearly upright, length about half aedeagal length, moderately concave, its lower marginal third curving anteriorly along the preatrium to articulation; aedeagal shaft posteriorly directed, quadrate in form with a beak at lower posterior corner, shaft basal depth of about base length. In dorsal view: Aedeagal shaft broad basally, narrowing to beaklike apex, a median crest anterior to apical gonopore. Connective Y-shaped; shaft length about fourth arm length.

Types: Lectotype male designated by P. W. Oman (1946), New York City, July, E. B. Southwick, and syntypes in Iowa State College Entomological Collections. Types studied.

Material studied: (New York) Otter Lake, July 25, Montauk; (Long Island) August 17; (Maryland) Piney Point; (Virginia) Fairfax County; (Florida) Lake Placid, Deerfield, Fort Walton, LaBelle, July 16, Plant City, Tampa, Daytona, Parish, Estero, May 6, Orlando, Sebastian, Fort Lauderdale, April 15, Morrison Field, November 2, Sanford, Hibernia, August 7; (Mississippi) Pachuta, Biloxi; (Louisiana) Eunice, December 24.

Notes: Range, in southeastern states and farther north along Atlantic Coast. As to habitat DeLong (1926) writes that it is found abundantly on short growths of *Juncus, Eleocharis* and *Scleria* at margins of freshwater lagoons. Dr. Ball (1927) states that it is abundant in the salt marsh areas of the Atlantic Coast.

105. *Paraphlepsius fuscipennis* var. *seminolus* (DeLong)

Phlepsius fuscipennis var. *seminolus* DeLong, Lloydia, vol. 1, 1938, p. 237.

Resembling *fuscipennis* in body form and coloration but pygofer spine differing; male pygofer in lateral view with spinelike process arising from pygofer dorsal border almost straight as it continues posteriorly from upper pygofer margin.

Genitalia: Female seventh sternum appears as in *fuscipennis* as well as do the male genital parts except for the straighter spine arising from margin of pygofer. This form is probably a variation of *fuscipennis.*

Types: Holotype male, allotype female, and male and female

paratypes Bell Glade, Florida (Clifton) deposited in collection of Dr. D. M. DeLong. Types studied.

Material studied: Type material.

Notes: Range, in Florida where speciation seems to be going on in the *fuscipennis* group.

106. *Paraphlepsius rileyi* (Baker)

Phlepsius rileyi Baker, Canadian Ent., vol. 30, 1898, p. 32.

Resembling *brunneus* in body form and coloration but crown more produced and body slightly larger, vertex of crown more conical; male pygofer in lateral view long and triangular with posteriorly directed spine at its posterior apex; aedeagal shaft in lateral view, with undulating border; female seventh sternum with posterior border truncate and excavated at middle by a deep V-shaped notch.

Genitalia: Female seventh sternum slightly less than two thirds as long as wide, lateral margins posteriorly converging uniformly from base, posterior lateral angles widely truncate, a wide V-shaped notch on middle with notch about three eighths sternum length. Male in lateral view: Pygofer triangular, upper margins sloping downward posteriorly and continuous with a posteriorly directed spine at upper edge of posterior angle, spine length about equals depth of pygofer at base of spine, greatest width of pygofer about three eighths its length. Aedeagal base posteriorly inclined, shortest length about two ninths aedeagal length, concave with its lower marginal two thirds curving anteriorly along an extended preatrium to articulation; preatrium continuous above with shaft proper; aedeagal shaft stout continuing upward curving posteriorly on basal third and again turning dorsad in an undulating manner, terminating in a tapering apex. In dorsal view: Aedeagus basally expanded with anterolateral bifid apodemal processes, apex squarely expanded around gonopore. Connective Y-shaped; arms widely separated; shaft broad and short, its length about fourth of arm length.

Types: Lectotype female, Texas, C. V. Riley, here designated, and syntypes in collection of C. F. Baker deposited in the U. S. National Museum. Specimens compared to types by Dr. P. W. Oman.

Material studied: (Kansas) Elk City, July 3, McPherson, Garnett, August 31; (Oklahoma) Lebanon, Sallisaw, Fort Gibson; (Arkansas) Fayetteville, June 20, Washington County; (Texas) Romney, Karnes County, Palopinto County, August 14, Dallas, Concan, Seguin, Burton, June 24.

Notes: Range, in Texas and adjacent states northward and eastward.

107. *Paraphlepsius incisus* (Van Duzee)

Phlepsius incisus Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 73.

Resembling *apertus* in body form and coloration but with narrower body and more uniform dark coloration; male pygofer in lateral view triangular with posteriorly directed spine at posterior apex; aedeagal shaft in lateral view straight with short dorsal and ventral beaks at the blunt apex; female seventh sternum with lateral margins strongly converging to narrow posterior border which is shallowly concave with a deep narrow V-shaped notch at middle.

Genitalia: Female seventh sternum about seven-tenths as long as wide, lateral margins converging extremely to rounding posterior lateral angles, short posterior margin slightly concave with a deep median V-shaped notch. Male in lateral view: Pygofer triangular, upper margin sloping downward to posterior angle, which is continuous with a posteriorly directed sinuous spine, greatest width of pygofer about seven tenths its length. Aedeagal base sinuately upright, length about half aedeagal length, its lower margin curving anteriorly along preatrium to articulation; aedeagal shaft vertical basal width about half base length, dorsoposteriorly directed in a stout shaft to blunt apex near upper pygofer margin, apex with paired beaks above and below. In dorsal view: Aedeagus widest at base diminishing to a bifid apex, subapically a pair of lateral retrorse beaks; stout lateral apodemes. Connective Y-shaped with arms roundly separated; shaft very wide and short.

Types: Lectotype male, Buffalo, New York, August 10, 1888, E. P. V. designated by P. W. Oman (1946) in Iowa State College Entomological Collections. One male syntype labeled as above and one female syntype Lancaster, New York, August, 1886, E. P. V. in same collections. Types studied.

Material studied: (Connecticut) New Haven; (New York) Chittenanga, New Haverhill; (D. C.) Washington, July 4; (Maryland) Plummer's Island, August 28; (West Virginia) Morgantown, Morgan County; (Tennessee) Clarksville, July 14; (Wisconsin) Eagleton, August 29, Spring Green; (Illinois) White Heath; (Iowa) Ames; (Kansas) Pottawatomie County, Doniphan County, July 20, Onaga.

Notes: Occurring in deciduous forest (mixed) with herbaceous plants in a hemlock-beech climax.

108. *Paraphlepsius brunneus* (DeLong)

Phlepsius brunneus DeLong, Tennessee State Bd. Ent. Bull. 17, 5: 1916, p. 74.

Resembling *tennessa* in body form and coloration but more uniform in dark brown colorations; aedeagal structure, in lateral view, a long curving horseshoe-shaped structure with attachment at middle of curvature, lower extension tapering to apex; male pygofer in lateral view with ventral beak at posterior apex; female seventh sternum with posterior lateral angles strongly produced and curved mesad, pair of median lobes closely separated by a deep median incision.

Genitalia: Female seventh sternum about four fifths as long as wide, lateral margin moderately converging from base but more so along posterior lateral angles which are strongly produced, a rounding obtuse lobe with a deep median incision on posterior margin. Male in lateral view: Pygofer, somewhat triangular, posterior angle rather truncate with a short ventral beak, upper margin sloping downward posteriorly, greatest width of pygofer about half its length. Aedeagus "horseshoe" shaped; aedeagal base inclined upward posteriorly, length about half aedeagal length, continuous below articulation with a ventrally directed large median prong process which curves gradually posteriorly terminating in paired points near plate apex; deep preatrium from articulation upward to shaft above; aedeagal shaft, posteriorly directed on proximal two thirds, then turned upward to a blunt rounded apex. In dorsal view: Aedeagus stout, apex bilobed; lateral apodemes stout and tapering; apex of ventral portion deeply bifid. Connective Y-shaped with stout rounding arms, their apices turned outward; shaft broad, expanding toward apex, its length about one fourth arm length.

Types: Cotypes, eight female and four male, Clarksville, Tennessee and Knoxville, Tennessee, July 6, 23, 28, in collection of Dr. D. M. DeLong and cotypes, male and female, Clarksville, Tennessee, July 5, 1915 D. M. DeLong, in Ohio State University Entomological Collections. Types were studied.

Material studied: (Ohio) Pickaway; (Tennessee) Hixon, Clarksville, June 20; (D. C.) Washington, July 4; (Maryland) Plummer's Island; (Virginia) Annandale Springs, July 21; (Georgia) Prattsburg; (Florida) Hilliard, August 19; (Alabama) Prattsville, July 21; (Mississippi) Prairie, July 27; (Arkansas) Berrytown, July 4, Fayetteville; (Louisiana) Tallulah, Hammond, June 22; (Kansas)

Douglas County, August 25, LaCygne, Conway Springs; (Texas) Seguin, June 26.

Notes: Range, east of Rocky Mountains.

109. *Paraphlepsius latifrons* Van Duzee

Phlepsius latifrons Van Duzee, Trans. Amer. Ent. Soc., vol. 19, 1892, p. 66.

Resembling *operculatus* in body form and coloration but differing in genital structures; male pygofer in lateral view triangular with a long beak arising from upper corner of short posterior margin and extending ventrad beyond lower pygofer border, no dorsal beaklike extension; female seventh sternum with acute posterior lateral angles with points curled under and darkened; angles continuous with an extremely broad and deep median V-shaped excavation.

Genitalia: Female seventh sternum about seven tenths as long as wide. Lateral margins contracted on basal third to rather parallel sides then slightly contracted posteriorly at the acute posterior lateral angles, posterior margin excavated by a broad sinuous V-shaped excavation from lateral angles to half way to base on median line. Male in lateral view: Pygofer somewhat triangular, anterior margin anterodorsally directed, upper margin rounded on anterior two thirds then contracted, posteriorly sloping to a corner below which is a ventrally directed hook extending beyond lower margin, greatest width of pygofer about seven elevenths length. Aedeagal base about upright, its length three fourths aedegal length, preatrium as an upright expanding portion to shaft; aedeagal shaft with basal width of one sixth base length, is directed posteriorly as a short tubelike portion with apex truncate. In dorsal view: Aedeagus broadest at articulation except for anterolateral lobelike projections and long stout lateral apodemes; the outside width of either is twice articulation width; shaft narrowed tubular to truncate apex. Connective somewhat Y-shaped but arms extremely widely separated; shaft broad and very short, about one-fourth arm length.

Types: Lectotype male, Odenton, Maryland, September 29, designated by P. W. Oman (1946) in the U. S. National Museum. Syntype female in same depository.

Material studied: (North Carolina) Raleigh, August 31, October 16, Nelson, August 31; (Georgia) Okefenokee Swamp, July 25, Chester; (Florida) Sanford, May 12, September 26, Daytona, May 22; (Mississippi) Port Gibson.

Notes: Range, in southeastern states.

110. *Paraphlepsius particolor* (Sanders and DeLong)

Phlepsius particolor Sanders and DeLong, Pennsylvania Dept. Agri., Gen. Bull. No. 346, 3, 1920, p. 15.

Resembling *rossi* in body form and coloration, but vertex of crown more produced and crown depressed, elytra densely marked, crown and scutellum lighter in color; in lateral view, ventral beak at posterior apex extending much below lower pygofer margin; aedeagal shaft in lateral view rectangular with dorsal projection at apex; female seventh sternum with lateral margins converging strongly to posterior lateral angles which are continuous with a median V-shaped excavation on posterior middle.

Genitalia: Female seventh sternum about three fourths as long as wide, lateral margins converging strongly from base forming a narrow posterior margin, posterior lateral angles as paired lobes separated by a deep V-shaped notch. Male in lateral view: Pygofer somewhat rectangular, but with upper marginal half sloping downward posteriorly to a short posterior margin, a ventrally directed sharp spine from lower posterior corner, greatest width of pygofer about seven tenths its length. Aedeagal base about upright, length slightly more than half aedeagal length, lower marginal third curving anteriorly along the preatrium to articulation; preatrium curves upward to shaft proper; aedeagal shaft with basal depth of half base length, is posteriorly directed from upper basal half to a short ventral beak on lower margin and a sharp marginal turn dorsally, with reduced apical third extending dorsoposteriorly to truncate apex with pair anterolateral beaks. In dorsal view: Aedeagus twice wider on basal third, apex bifid lobed; anterolateral apodemes prominent. Connective Y-shaped with stout arms roundly spread; shaft very wide and short, expanding apically.

Types: Cotypes, male and female, Kane, Pennsylvania, August 18, 21, 23, 1919, D. M. DeLong, deposited in collection of Dr. D. M. DeLong.

Material studied: (Pennsylvania) Kane, August 19; (Mississippi) Leland, Lexington, August 16; (Manitoba) Morris, August 10; (Minnesota) Itasca Park, Norman County, September 4.

Notes: Range, in eastern North America. Is found in restricted habitat of rich herbaceous growths in a moist area of deciduous woodlands (DeLong 1926). Short grasses together with *Luzula campestris, Sanicula canadensis,* and *Viola blanda* and hemlock-beech climax (DeLong 1926).

Synopsis of the Genus PHLEPSANUS Oman

Phlepsanus Oman, Memoirs Ent. Soc. Washington, No. 3, 1949, p. 140.

Originally described as follows:

"Type of the genus, *Phlepsius nigrifrons* Ball, 1916.

"Very robust leafhoppers. Head broadly rounded anteriorly, wider than pronotum, bluntly rounded to the face. Face evenly convex; clypeus broad basally and tumid, not flattened below the dorsal margin of the face. Crown convex, longer medially than next eye. Forewing broad, appendix distinct but small, but few extra veinlets present and these very weak, inner anteapical cell open basally. Male plates short and broad, spine-like setae uniseriate. Tenth segment short, not sclerotized dorsally except as a short terminal band. Pygofer setose, unarmed. Connective narrowly Y-shaped, slender, extended caudad beyond point of articulation of aedeagus as a spine-like projection. Aedeagus slender, recurved, broad basally for muscular attachment; gonopore apical. Style simple. Color creamy or cinerous with fuscous marks, usually in the form of rather coarse vermiculate or ramose lines.

"In the type of genitalia the members of this genus are close to *Texananus*, and further study may show that their association with that genus will result in a more logical arrangement than retention as a separate entity.

"Distribution: Southwestern United States and adjacent Mexico."

KEY TO THE SPECIES OF PHLEPSANUS OMAN

1. Connective shaft separated into short paired parallel spine-like processes posterior to aedeagal articulation. Female seventh sternum with a wide median notch as wide as deep, about one fifth distance to base from posterior margin. Small forms 2
   Connective shaft as a single ventral process posterior to articulation. Female seventh sternum appears as paired double plates with a median excavation to base. Large, robust forms 3

2.(1) Body coloration stramineous to whitish, vermiculate lines rather obscure ..... 111. *denudatus*
   Body with vermiculate markings more distinct on head and pronotum. Elytra with oblique dark bands, the middle one most distinct ..... 112. *denudatus* var. *carpolus*

3.(1) Male plates long, about twice valve length mesally, narrowing to slightly turned out apices. Female seventh sternum apparently consisting of paired lateral plates underlying pair of broad median plates with undulating inner margin against a median excavation to base 5
   Male plates shorter than valve length mesally, widest basally, strongly narrowing laterally to a rather truncate apex. Female seventh sternum apparently as a pair of lateral plates underlying shorter median triangular plates separated by an excavation to base 4

4.(3) Connective shaft tapering to a slender apical portion, apex very slightly turned ventrad. Median plates of female seventh sternum well separated at base by an excavation ..... 113. *angustus*

Connective shaft apical fourth curved ventrad to a slightly bifid apex. Median plates of female seventh sternum touching at base or nearly so ..... 114. *nigrifrons*

5.(3) Connective shaft apical portion curved ventrad in large curve tapering to a sharp apex slightly turned posteriorly. Excavation of female seventh sternum roundly narrowed, its width less than lateral sternum plate ..... 115. *tumidatus*

Connective shaft apical portion curved ventrad in large curve to a bifid apex in lateral view. Excavation of female sternum more or less rounded at middle and about as wide as sternum lateral piece ..... 116. *vanduzei*

111. *Phlepsanus denudatus* (Ball)

Phlepsius denudatus Ball, Canadian Ent., vol. 33, 1901, p. 11.

Resembling *angustus* in body form and coloration but much smaller and with usually pale coloration; aedeagal shaft in lateral view uniformly tapering and curving dorsad from attachment; connective shaft divided into a pair of straight short processes; female seventh sternum short with posterior margin truncate, only slightly produced on middle, excavated and with a semicircular notch.

Genitalia: Female seventh sternum about two fifths as long as wide, lateral margins roundly converging from base, posterior lateral angles not produced, posterior margin slightly convex with a wide rounded excavation at middle. Male in lateral view: Pygofer somewhat rectangular, upper and lower margins converging posteriorly on posterior third to a bluntly rounded posterior margin, greatest width of pygofer about two thirds its length. Aedeagal base from articulation to apodemal processes about one third of aedeagal length; apodemal processes arising anteriorly from near articulation curve dorsally and posteriorly to a blunt point; shaft with depth almost equal to base length, is posteriorly directed then curving upward and tapering to a slender apex. Connective ventral shaft broad at aedeagal articulation, extending posteriorly as a short pair of processes tapering to a point. In dorsal view: Aedeagus widest basally, narrowing along shaft to apex; lateral apodemal processes long and apically rounded. Connective Y-shaped with arms closely paralleling; slender shaft wider at aedeagal articulation, its length more than one third as long as arm.

Types: Lectotype male, Grand Junction, Colorado, July 28, 1900, here designated and syntypes from same locality, in collection of

E. D. Ball deposited in the U. S. National Museum. Two syntypes in Snow Entomological Collections, University of Kansas.

Material studied: (Utah) Glenwood, August 13, Wellington, Goshen; (Colorado) Grand Junction; (New Mexico) White Sands, Alamagordo, June 30; (Arizona) Tucson, June 18; (California) Cuyama Ranch, Mojave, July 7, Palmdale, Indio, Mint Canyon, Jacumba, August 8, Palm Springs.

Notes: Range, in western and southwestern states.

112. *Phlepsanus denudatus* var. *carpolus* (Ball)

Phlepsius (*Dixianus*) *denudatus carpolus* Ball, Pan-Pacif. Ent., vol. 8, 1931, p. 87.

Resembling closely *denudatus* in body form and coloration, but with oblique bands on the elytra.

Genitalia: Identical with or very similar to that of *P. denudatus* Ball.

Types: Holotype female, allotype male, and six paratypes, Arizona, May 6, 1931, E. D. Ball, in collection of E. D. Ball deposited in the U. S. National Museum. Homotype in Snow Entomological Collections, University of Kansas.

Material studied: (Arizona) Tucson Mountains, June 18, November 19; (California) Palm Springs, December 12, Indio, December 22.

Notes: Range, same as for *denudatus*.

113. *Phlepsanus angustus* sp. nov.

Resembling *Phlepsanus nigrifrons* (Ball) but lighter in color with less markings on face, head slightly wider, male connective shaft in lateral view tapering to a posteriorly directed slender apex, female seventh sternum median plate widely excavated to base. Length 7.25 mm.

Structure: Crown broad, convex, slightly longer at middle than next to eye, rounding to front. Clypeus slightly less tumid than in *P. nigrifrons*. Clypellus slightly constricted basally. Pronotum with anterior and posterior margins almost parallel, slightly rugose posteriorly. Elytra broad but compressed posteriorly.

Color: General color of dorsum stramineous to milky. Crown with pair of small round black spots at base and with pair of dark arcuate vittae on front margin. Clypeus stramineous with often several faint pairs of lateral transverse arcs under the dark basal margin. Pronotum sometimes slightly inscribed with fuscous. Scutellum occasionally with three faint ivory spots at posterior border margined with light brown. Elytra milky with few scattered

vermiculate marks and brown flecks; a more or less dark stripe starts beneath margin of pronotum following claval border to its middle, then curves downward slightly to run along the long discal cell fading out near second apical cell.

Genitalia: Female seventh sternum about five twelfths as long as wide, lateral margins of underlying lateral plates slightly rounded, posterior lateral angles slightly produced, their inner oblique margins anteriorly reaching truncate apices of paired medial plates; medial plates separated by a deep rounded excavation to base. Male in lateral view: Pygofer somewhat rectangular, upper posterior corner rounded, hind margin sloping anteroventrally to rounded lower posterior corner, greatest width of pygofer two thirds its length. Aedeagal base, inclined dorsoposteriorly, its length almost half aedeagal length, angularly concave at middle with lower marginal half curving anteriorly along a narrow preatrium to articulation; aedeagal shaft with basal width of about one third base length, posteriorly directed, swelling proximally then tapering as it sharply curves dorsoanteriorly into a rather straight middle portion tapering to apex, apical fifth, anteriorly directed. Connective ventral shaft tapering posteriorly to a slender slightly turned down apex. In dorsal view: Aedeagus basally expanded laterally into prominent bluntly rounded apodemes, then suddenly diminishing into the tapering shaft. Connective Y-shaped with arms expanded laterally, then narrowed on apical third; shaft widest basally, narrowing anterior to articulation, then slightly tapering to an abruptly sharpened apex.

Types: Holotype male, allotype female, 6 male and 6 female paratypes, Santa Rita Mountains, Arizona, June 12, 1933, R. H. Beamer. Deposited in Snow Entomological Collections, University of Kansas.

Material studied: Only type material.

Notes: Range, in the mountainous region of the southwest.

114. *Phlepsanus nigrifrons* (Ball)

Phlepsius nigrifrons Ball, Canadian Ent., vol. 37, 1905, p. 210.

Resembling *angustus* in body form and coloration, but head slightly narrower and more markings on face and body; connective ventral shaft in lateral view stout, posteriorly directed, then on apical fourth curving ventrad to an acutely truncate apex; female seventh sternum with median plates closer together with excavation to base V-shaped.

Genitalia: Female seventh sternum one-third as long as wide, lateral margins converging from base to posterior lateral angles, the inner margins of which direct obliquely anterior to the apices of a pair of large median lobe-like plates, separated by a V-shaped notch to base. Male in lateral view: Pygofer somewhat rectangular, posterior margin slightly convex above middle, greatest width two thirds length. Aedeagal base nearly upright, shortest length three eighths aedeagal length, concavely V-shaped with short preatrium; aedeagal shaft with basal width of half base length, posteriorly directed from middle of base to distance of twice base length, curving dorsally in a long slender tapering portion, then curving anteriorly on apical fourth to apex. Connective shaft posterior to aedeagal articulation stout and of uniform size, posteriorly directed to a ventrally curved apical fourth, apex sharply truncate. In dorsal view: Aedeagus broad to slender tapering shaft; anterolateral apodemal processes moderately long, apices blunt. Connective Y-shaped; shaft widened at articulation, narrowing to slender apex.

Types: Lectotype male, No. 10438 USNM, Hot Springs, Arkansas, 24-6, Barber and Schwarz, here designated, and syntype female in collection of E. D. Ball deposited in the U. S. National Museum. Homotype male and female, Santa Rita Mountains, on hand for study.

Material studied: (Arizona) Santa Rita Mts., June 12, Tucson, May 31, Phoenix, July 10, Bradshaw Mt., October 12, Verde Valley, Sta. Cruz River, Nogales, Patagonia, September 20, San Carlos, Superior, August 6.

Notes: Range, in Arizona and southward into Mexico.

115. *Phlepsanus tumidatus* sp. nov.

Resembling *Phlepsanus vanduzei* (Ball) in general form and color, but coloration darker with more markings on head and pronotum, trilobed commissural line more distinct, excavation of last ventral segment widest near base, and shaft of connective with apex not bifid. Length 7.75 mm.

Structure: Crown one fourth longer at middle than next to eye, slightly convex, bluntly rounding with front. Clypeus round wedge-shaped, length about equal to basal width. Clypellus slightly constricted on basal half. Pronotum slightly convex, wide and transversely rugose. Elytra compressed slightly anterior to flaring apex.

Color: Dark brown coloration on dorsum of body, white ivory areas irregularly placed. Crown with two small black spots at base.

Face darkened above with numerous short lateral horizontal arcs on clypeus, dark spots on clypellus, lorum, and gena under eye. Pronotum and scutellum with a pair of dark separated elongated areas across their lateral borders. Scutellum yellowish along middle. Elytra marked with a distinct trilobed commissural line along clavus, four or more dark costal spots; outer apical and costal veins bordered with brownish markings, spaces between hyaline.

Genitalia: Female seventh sternum about two fifths as long as wide, lateral margins converging from base, large posterior lateral angles not produced, pair of narrow lateral plates following contour of sternum almost to its median excavation, these plates are median to narrow lateral strips or folds; the less produced middle disc excavated to base, margins of excavation opening posteriorly rounded, excavation usually widest near base and conspicuous for its margin's sinuous folding. Male valve triangular, corners rather acute. Plates long, broadest on basal third, sides converging to sharp apices along median line. Male in lateral view: Pygofer rather rectangular, rounding on posterior margin, its greatest width about two-thirds length. Aedeagal base nearly upright, its length one fourth aedeagal length, concave with lower marginal half curving anteriorly along the preatrium to articulation; aedeagal shaft slender, tapering to apex, posteriorly directed a distance of third aedeagal length, then abruptly turning dorsad on middle portion, curving anteriorly on apical fifth to a blunt apex. Connective shaft widest at aedeagal articulation, apically turned ventrad in long stout hook, tapering to a posteriorly curved point. In dorsal view: Aedeagal base much wider than tapered apical portion; apodemal horns prominent at anterior basal border. Connective Y-shaped with arms close together; shaft length two fifths longer than arm length.

Types: Holotype male, allotype female, 3 male and 7 female paratypes, Seward County, Kansas, July 23, 1944, R. H. Beamer. Deposited in Snow Entomological Collections, University of Kansas.

Material studied: Only type material.

Notes: Collected on *Artimesia* by R. H. Beamer.

116. *Phlepsanus vanduzei* (Ball)

Phlepsius vanduzei Ball, Canadian Ent., vol. 33, 1901, p. 9.

Resembling *tumidatus* in body form and coloration but coloration lighter and less markings on head and pronotum, trilobed commissural line less distinct; connective ventral shaft in lateral view with apical third curved ventrad to a bifid apex, posterior cleft point

directed strongly posterior; female seventh sternum with excavation to base widest near the middle point.

Genitalia: Female seventh sternum five elevenths as long as wide, lateral margins converging from base, posterior lateral angles not produced, a pair of lateral plates widening posteriorly and produced beyond seventh sternum, these median to narrow lateral plates or fold, the less produced middle of sternum excavated to base, margins of excavation opening rather rounded, excavation widest at middle, narrower at base and conspicuous for its margin's sinuous folding. Male in lateral view: Pygofer parallelogram in shape, upper posterior corner rather cut away, its greatest width about two thirds length. Aedeagal base nearly upright, its length one third aedeagal length, concave at middle with lower marginal half curving along preatrium to articulation; aedeagal shaft with basal width of two fifths base length, posteriorly directed on proximal third tapering slightly as it curves upward and anteriorly on apical fourth to a blunt apex. Connective ventral shaft stout, posteriorly directed on proximal third tapering slightly as it curves upward and anteriorly on apical fourth to a blunt apex. Connective ventral shaft stout, posteriorly directed on proximal five-eighths then curving roundly ventrad to a bifid apex, the posterior cleft point turned strongly posteriorly. In dorsal view: Aedeagus basally widened bulblike, then reduced suddenly to slender shaft; lateral apodemes from middle of widened base moderately long with blunt apex. Connective Y-shaped; shaft stout roundly widest anterior to articulation then tapering gradually to bluntly pointed apex.

Types: Lectotype female, Grand Junction, Colorado, July 28, 1900 here designated, and syntype male in collection of E. D. Ball deposited in the U. S. National Museum. Homotype male and female on hand for study.

Material studied: (Utah) Cedar, Parowan, July 21, September 6, St. George, Cisco, August 7, Monroe, Draper; (New Mexico) White Sands, June 27; (Nevada) Elko, Winnemucca, July 30; (Arizona) Tucson, May 19, June 19, Mescal, Mariposa County.

Notes: Range, in Rocky Mountain States.

Synopsis of the Genus APLANUS Oman

Aplanus Oman, Memoirs Ent. Soc. Washington, No. 3, 1949, p. 138.

Originally described as follows:

"Type of the genus, *Eutettix pauperculus* Ball, 1903.

"Small to medium-sized leafhoppers, length 3 to 5 mm. Head slightly wider than pronotum, anterior margin clearly delimited but not angled; face broad;

clypellus constricted at base. Crown usually slightly concave, sometimes flat or slightly convex, always with a more or less definite transverse impression anteriorly; median length longer than length next eye, sometimes one and one-half times as long. Lateral margins of pronotum not carinate. Forewing with numerous false veins or partial cross-veins, these usually marked with tiny tawny or fuscous spots, sometimes with tiny spots in cells; appendix well developed; inner anteapical cell open basally. Male plates triangular in outline, tips attenuate and with a few fine, filamentous setae; spine-like setae uniseriate. Tenth segment sclerotized laterally, not sclerotized dorsally except as a narrow distal band. Aedeagus with shaft compressed, bearing a pair of short sinuous terminal processes which are directed latero-cephalad; dorsal apodeme flattened. Color yellowish or greenish white with tawny to fuscous spots."

KEY TO THE SPECIES OF APLANUS OMAN

1. Aedeagus in lateral view with upright basal third of shaft almost straight. Female seventh sternum rather long, not excavated on either side of a shallow median notch ..... 117. *albidus*

   Aedeagus in lateral view with shaft bent to form semicircle. Female seventh sternum truncate either side of a median prolongation ..... 118. *pauperculus*

117. *Aplanus albidus* (Ball)

Phlepsius albidus Ball, Canadian Ent., vol. 32, 1900, p. 203.

Resembling *pauperculus* in body form and coloration, but slightly larger and darker, with greenish irrorations; aedeagal shaft in lateral view nearly parallel with upright base; male pygofer in lateral view almost twice as long as wide; female seventh sternum about as long as wide, posterior margin convex with small median notch.

Genitalia: Female seventh sternum about three-fourths as long as wide, lateral margins narrowing on posterior third and continuous with convex posterior margin slightly produced on middle half with a shallow notch. Male in lateral view: Pygofer somewhat rectangular, a diagonal margin cutting off lower posterior corner, its greatest width slightly more than half length. Aedeagal base posteriorly inclined, length half aedeagal length; aedeagal shaft with basal width of half base length, posteriorly directed a distance of two thirds base length then curving dorsoposteriorly at about right angles, paralleling base and tapering to apical third which curves dorsally and bears at apex a pair of anteriorly directed slender processes. In dorsal view: Aedeagus nearly four times wider than slender shaft; apex cleft with recurved anterolaterally directed slender processes. Connective Y-shaped with arms thickened subapically, slender apices curved outward; shaft slender but enlarged apically, its length about half arm length.

Types: Lectotype female, Pueblo, Colorado, September 15, 1898, here designated and three female syntypes in collection of E. D. Ball deposited in U. S. National Musuem. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Colorado) Palisade, Garden of the Gods, August 19; (Utah) Monroe, June 26; (New Mexico) White Sands, June 7, Alamagordo, June 30; (Arizona) Douglas, Black Mountain, July 13; (California) Mojave, July 7.

Notes: Range, in the Rockies and foothills of the western states. For host plant, E. D. Ball gives *Atriplex confertifolia.* Following the careful study of both genera *Eutettix* (1942) and *Norvellina* (1940) the position of *A. albidus* was in doubt. Recently Doctor Oman (1949) set up the genus *Aplanus* for this species.

118. *Aplanus pauperculus* (Ball)

Phlepsius pauperculus Ball, Canadian Ent., vol. 35, 1903, p. 228.

Resembling *albidus* in body form and coloration but smaller, and pale greenish white; aedeagal shaft in lateral view curving rather uniformly from its base to apex nearly in line with the base extended; male pygofer in lateral view only about half longer than wide; female seventh sternum short, posterior half of lateral margins converging strongly, posterior margin truncate laterally and convex on middle.

Genitalia: Female seventh sternum about half as long as wide, lateral margins slightly converging from base on anterior half, more strongly converging posteriorly to truncate posterior lateral angles on either side of a median produced rounded third. Male in lateral view: Pygofer nearly rectangular, lower posterior corner rounded, greatest width five sevenths length. Aedeagal base inclined slightly anteriorly, its length half aedeagal length; aedeagal shaft with basal width of two thirds base length, posteriorly directed proximally diminishing in size as it curves dorsally in short curvature, then anteriorly as a rather straight apical two thirds, apex with pair of slender processes ventrally retrorse along apical fourth. In dorsal view: Aedeagus broad basally, gradually tapering along a relatively wide shaft to apex, apex with posterior laterally recurved slender processes. Connective Y-shaped, shaft widened apically, its length half arm length.

Types: Lectotype female, Grand Junction, Colorado, July 28, 1900, here designated, and two syntypes with same data in collection of E. D. Ball, deposited in the U. S. National Museum. Specimens compared with types by Dr. P. W. Oman.

Material studied: (Utah) Helper, August 12, Dixie, September 9.
Notes: Range, in Utah and other western states.

Synopsis of the Genus REMADOSUS Ball

Remadosus Ball, Trans. Amer. Ent. Soc., vol. 55, 1929, p. 2-3.

Originally described as follows:

"Intermediate in character between true *Athysanus* and true *Phlepsius* evidently related to *Selanocephalus* in the location of ocelli on front below the vertex margin. Large species with extremely broad short rounding heads heavily and very uniformly irrorate with fuscous sometimes omitting transverse bands on vertex and pronotum and a few definite spots on elytra.

"Vertex transverse, almost parallel margined, broadly rounding to front; front very broad, about parallel margined to the antennae then wedge-shaped to clypeus. Clypeus expanding towards apex, the margins of genae deep and broadly rounding below. Ocelli in suture, distant from eyes, well under the vertex level and situated in a broad depression which gives the impression of a slightly produced apex to head. Pronotum short, transverse, broadly curved in front, the lateral margins long and carinate. Elytra long, slightly narrowing apically; venation as in *Athysanus*, the apical and anteapical cells nearly parallel margined. Type of the genus *Athysanus magnus* Osborn and Ball."

Forewing with appendix small or absent, outer and central anteapical cells long and narrow, inner anteapical cell usually basally open, apical cells short; male plates triangular, spinelike setae uniseriate; connective Y-shaped; aedeagus asymmetrical, strongly recurved, broad basally and tapering distally, gonopore subterminal; pygofer setose.

KEY TO THE SPECIES OF REMADOSUS BALL

1. Ivory white costal stripe on wings. Aedeagus in lateral view curved throughout to apex 2
   With ivory white costal stripe. Aedeagus in lateral view tapering and almost straight on apical half ..... 119. *fumidus*
2.(1) Aedeagus ending in a slender process recurved to the right. Female seventh sternum with median produced lobes nearly equalling size of lateral angles ..... 120. *magnus*
   Aedeagus sharpened at apex with subapical recurved process. Female seventh sternum with median posterior lobes closely adjacent and much smaller than posterior lateral angles. 121. *piceus*

119. *Remadosus fumidus* (Osborn)

Eucelis (*Athysanus*) *fumidus* Osborn, Florida Ent., vol. 6, 1922, p. 19.
Eucelis (*Athysanus*) *drakei* Osborn, Florida Ent., vol. 6, 1922, p. 19.

Resembling *magnus* in body form and coloration but much darker with a deep brownish black; aedeagal shaft in lateral view straight on proximal half; female seventh sternum with posterior lateral

angles and median pair of lobes about equally produced with moderately deep rounded concavities on either side of median lobes.

Genitalia: Female seventh sternum half as long as wide, lateral margins roundly converging from base, posterior lateral angles strongly produced into two lobes separated by a rather deep notch. Male in lateral view: Pygofer nearly rectangular, upper posterior corner rounded, a very small point at lower posterior corner, greatest width of pygofer two thirds its length. Aedeagal base upright, length half aedeagal length, no apparent preatrium; aedeagal shaft with basal width of about half base length, posteriorly directed from lower base portion, curving dorsad and slightly anterior on its proximal third, tapering along a straight apical two thirds to apex above pygofer, with posteriorly recurved slender process. In dorsal view: Aedeagus widest at base, uniformly narrowing along shaft to apex, with recurved process asymmetrically lying on right side. Connective Y-shaped with arms somewhat parallel; shaft broad, its length three fifths arm length.

Types: Holotype male, Chester, Georgia, April 25, 1904, and paratype females, Gainesville, Florida, C. J. Drake, April 20, 1918, deposited in Herbert Osborn Collection, Ohio State University Entomological Collections. Types studied.

Material studied: (Georgia) Adel, August 11, Folkston, Okefenokee Swamp, July 25; (Florida) Hilliard, August 6, Suwannee Springs, Alachua County, July 9, Lake Placid, July 13.

Notes: Range, in southern Georgia and southward in Florida. Due to study of a large series of *R. fumidus* which consisted of only males and in like manner a series of *R. drakei,* females collected from the same locality on the same day or within period of a few days, it seems conclusive that these forms are male and female of the same species.

120. *Remadosus magnus* (Osborn and Ball)

Athysanus magnus, Osborn and Ball, Proc. Iowa Acad. Sci., vol. 4, 1897, p. 225.

Resembling *piceus* in body form and coloration but ashy in coloration; aedeagal shaft apically recurved as a slender process; female seventh sternum with median lobes nearly equalling size of lateral angles.

Genitalia: Female seventh sternum seven twelfths as long as wide, lateral angles strongly and roundly produced, two conspicuous rounded lobes on middle of posterior margin separated by a rather large V-shaped notch. Male in lateral view: Pygofer somewhat

rectangular, greatest depth near posterior half about seven twelfths length, upper and lower margins angularly rounded above and below, a slight notch at lower posterior corner. Aedeagal base upright, its length three sevenths aedeagal length, preatrium apparently absent; aedeagal shaft with basal depth of half base length, posteriorly directed a distance of two thirds base length, then diminishing in size as it curves uniformly upward in large arc and anterodorsally to apex with a recurved slender process. In dorsal view: Aedeagus basally broad, bulbous, narrowing rapidly to base of the long tapering shaft. Connective Y-shaped, with very stout arms, apically narrowed to point on their inner margins; shaft very broad, about width of aedeagal base with its length about arm length.

Types: Holotype female, Ames, Iowa, August 14, 1896, paratype male, Ames, Iowa, August 12, 1896, Herbert Osborn and E. D. Ball, and paratype male, Lincoln, Nebraska, August, by same collectors, in Herbert Osborn Collection deposited in Ohio State University Entomological Collections. Types studied.

Material studied: (Iowa) Ames, August 19, Little Rock; (Mississippi) Pearlington, Pasagoula; (North Dakota) Tokio, July 28; (Nebraska) Valley; (Kansas) Stafford County Salt Marsh, Neosho County, Douglas County, August 14, Ottawa, Meade County, September 19, Medora.

Notes: Range, in the central states from Texas northward.

121. *Remadosus piceus* (Osborn)

Eucelis (*Athysanus*) *magnus*, var. *piceus* Osborn, Florida, Ent., vol. 6, 1922, p. 20.

Resembling *magnus* in body form and coloration but generally darker; aedeagal shaft with the recurved process subapical to a slender sharpened apex; female seventh sternum with median pair of lobes small separated by a small median notch.

Genitalia: Female seventh sternum about one half as long as wide, lateral margins slightly converging from base, posterior lateral angles slightly produced, about even with a pair of toothlike lobes at middle separated by a small V-shaped notch, dark colored. Male in lateral view: Pygofer somewhat rectangular, upper posterior corner rounded, and a small beak at the lower posterior corner, greatest width of pygofer about half its length. Aedeagal base nearly upright, its length about half aedeagal length, preatrium not present; aedeagal shaft with basal width of two thirds base, posteriorly directed on its proximal fourth, rapidly reducing in

width, then curving dorsally and anteriorly in large rounding curve to a very slender spinelike apex, subapically a median recurved process. In dorsal view: Aedeagus broadest at articulation, rapidly tapering to slender tapering shaft to its apex. Connective Y-shaped, with arms sinuously parallel; shaft broad, expanded at articulation, its length about three-fifths arm length.

Types: Holotype female, Pascagoula, Mississippi, August 8, 1921, H. L. Dozier in collection of Herbert Osborn deposited in the Ohio State University Entomological Collections. Type studied.

Material studied: (Mississippi) Pass Christian, June 25; (Florida) Tampa, September 27.

Notes: Range, in the southeastern states. Because of distinct genitalia this varietal form was raised to species rank.

Synopsis of the Genus DORYDIELLA Baker

Dorydiella Baker, Canadian Ent., vol. 29, 1897, p. 159.

Originally described as follows:

"Head broader than prothorax and somewhat longer, more than twice as broad as long, anteriorly foliaceous, angulate, and inclined upward. Face normal. Ocelli on the edge between vertex and face, adjoining the eyes. Elytra long and narrow, with a narrow appendix, somewhat exceeding abdomen, toward the apex narrowed to an acute point. Apical cells four, anteapical two, basal cross vein entering radial cell. Clavus with two longitudinal veins. Wings with three apical cells exclusive of the closed costal.

"This genus is much like *Dorydium* in everything except the head, which is far shorter. Type:—*Dorydiella floridana.*"

Clypeus and clypellus relatively narrow, disc of crown shallowly concave; forewing appendix slender, apical and anteapical cells slender, male plates triangular, spinelike setae uniserate; connective short quadrate, H-shaped; aedeagus with paired processes, gonopore subapical on ventral surface of shaft; pygofer with lobe-like tooth directed posteriorly from inner margin.

KEY TO THE SPECIES OF DORYDIELLA BAKER

1. Male aedeagal apical fourth in lateral view strongly contracted on ventral margin beyond ventral processes, apex broadly rounded. Female seventh sternum with posterior margin produced on middle third considerably beyond the slightly produced posterior lateral angles ..... 122. *floridana*

   Male aedeagal apical fourth in lateral view not strongly contracted on ventral margin beyond ventral processes, female seventh sternum with posterior lateral angles roundly produced, about even with a pair of median produced lobes ..... 123. *kansana*

122. *Dorydiella floridana* Baker

Dorydiella floridana Baker, Canadian Ent., vol. 29, 1897, p. 159.

Resembling *kansana* in body form and coloration but aedeagal apical fourth in lateral view strongly contracted on ventral margin beyond ventral processes; female seventh sternum with posterior lateral angles small but median portion of posterior margin extremely produced forming pair of rounded apical lobes at apex.

Genitalia: Female seventh sternum about five sevenths as long as wide, lateral margins almost parallel, posterior margin with two distinct median lobes strongly produced much beyond lateral angles and separated by a rounded notch. Male in lateral view: Pygofer nearly triangular, dorsal margin paralleling ventral margin on anterior third of pygofer, then upper margin slopes downward to a slightly turned down beak, greatest width about five sixths length. Aedeagal base almost upright, its length about three fourths aedeagal length; aedeagal shaft with basal width of two fifths base length, departing lower portion of base posteriorly, constricting slightly on proximal half, then expanding somewhat on apical half with apex rounded, at point of greatest width one pair of spinelike processes extend downward, and a second short pair extends dorsoposteriorly, apical portion beyond ventral processes strongly contracted on ventral side. In dorsal view: Aedeagus with wide rectangular base; shaft about one third as wide as base, tapering slightly to rounded apex, paired processes extend anterolaterally in a retrorse manner. Connective rather U-shaped, its shaft as a pair of articulating lobes.

Types: Holotype, Florida, in collection of C. F. Baker deposited in the U. S. National Museum. Homotype on hand for study.

Material studied: (Tennessee) Clarksville, August 2; (Florida) Daytona, September 5.

Notes: Range, in Florida swamp areas and other southeastern states.

123. *Dorydiella kansana* Beamer

Dorydiella kansana Beamer, Jour. Kansas Ent. Soc., vol. 18, 1945, p. 48.

Resembling *floridana* in body form and coloration but aedeagal shaft in lateral view with apical fourth only slightly contracted; female seventh sternum with posterior lateral angles roundly produced about even with the pair of median produced lobes.

Genitalia: Female seventh sternum about five eighths as long as wide, lateral margins concavely converging on their posterior half, posterior lateral angles narrowly produced, two median produced

lobes separated by a deep notch on posterior margin. Male in lateral view: Pygofer nearly triangular, upper margin paralleling lower on anterior half of pygofer, then curving downward to posterior angle, short turned down beak at posterior angle, greatest width of pygofer about five eighths its length. Aedeagal base upright, length about three-fifths aedeagal length; aedeagal shaft with basal width about one fourth base length, posteriorly directed on basal third, then curving obliquely upward, slightly widening toward the apical third where it tapers to a bluntly rounded apex, at point of greatest expansion on side of shaft one pair of curved spines arise projecting downward and a second pair projects upward. In dorsal view: Aedeagus about three times wider basally than on narrow shaft which tapers to apex, subapically the upper pair of retrorse spines curve outward, lateral apodemal horns prominent. Connective about U-shaped, its shaft as paired separated articulating lobes.

Types: Holotype male, allotype female, 13 male and 14 female paratypes, Meade Co., Kansas, July 24, 1944, R. H. Beamer; other paratypes three males and two females, same place and collector, September 9, 1944. Types deposited in Snow Entomological Collections, University of Kansas.

Material studied: Only type material.

Notes: Range, Kansas. Habitat swampy areas.

Synopsis of the Genus ORIENTUS DeLong

Orientus DeLong, Ohio Jour. Sci., vol. 38(4), 1938, p. 217.

Originally described as follows:

"Allied to *Phlepsius*. Elytra marked with ramose pigment lines. Vertex almost parallel margined, broadly rounded with a depressed transverse line back of margin. Vertex margin broadly rounded to outer margins, forming a conspicuous tooth. Pygofers with long processes arising dorsally on inner margins near anal tube and extending apically and ventrally.

"Type of Genus *Phlepsius ishidae* Mat.

"Although described as a member of this genus, recent study has indicated that it is quite distinct from the other groups previously placed under the name *Phlepsius*."

Head narrower than pronotum, clypeus narrow, about one-fourth longer medially than next to eye; forewing long, narrow, appendix well developed, inner anteapical cell opened basally, central anteapical cell twice as long as outer; male plate long and slender, triangular, terminating in a pair of slender lobes and notched as above, no spine-like setae; aedeagus small, shaft short, gonopore apical; pygofer heavily setose.

The Species of *Orientus* DeLong

124. *Orientus ishidae* (Matsumura)

Phlepsius ishidae Matsumura, Termész. Füzetek, vol. 25, 1902, p. 382.
Phlepsius tinctorius Sanders and DeLong, Ann. Ent. Soc. Amer., vol. 12, 1919, p. 285.

Resembling other Phlepsius-like forms but head narrower than pronotum and with a transverse sulcus; plates without setae and with their apical portion incised and strongly contracted on medial border forming a slender apical third.

Genitalia: Female seventh sternum about three-fifths as long as wide, lateral margins almost parallel, posterior lateral angles scarcely produced, posterior margin slightly convex. Male in lateral view: Pygofer somewhat rectangular, upper margin sloping ventrad from its anterior third to the upper posterior corner, a longer spinelike process arising inside the middle of upper margin, is posteriorly directed to apex near middle of posterior margin, lower posterior corner rounded, greatest pygofer width about half its length. Aedeagal base nearly upright, inclined somewhat posteriorly, its length only slightly less than aedeagal length, preatrium from articulation to shaft long; aedeagal shaft short, with basal depth of one sixth base length, posteriorly directed on proximal two-thirds and turned dorsad apically to a blunt point. In dorsal view: Aedeagus with broad, triangulate portion at articulation, similar to the shape of the broad apodemal portion, base between these half as wide; shaft narrow, slightly expanding apically.

Types: Fundorte: *Sapporo*, gesammelt von Herrn M. Ishida, und *Tokio* (?), gesammelt von Herrn Dr. S. Onuki. (Zwei Exemplare in meiner Sammlung.) Types of *P. tinctorius* Sanders and DeLong studied.

Material studied: (Connecticut) New Haven, August 16; (Maryland) Annapolis, August 2.

Notes: Range, known to be in Japan and eastern United States. It has been collected from *Aralia spinosa*. Probably introduced to the United States in the egg stage on some shrubs of the genus *Aralia*, possibly the species *A. chinensis*.

Synopsis of the Genus TROPICANUS DeLong

Phlepsius subgenus *Tropicanus* DeLong, Proc. Ent. Soc. Wash., vol. 46, 1944, p. 87.

Originally described as follows:

"The vertex is short and bluntly angled and gradually rounded to the front without a definite margin. The head is wider than the pronotum. The middle

anteapical cell is long, decidedly exceeding the outer anteapical cell both anteriorly and posteriorly. The elytra are usually conspicuously marked with brown ramose pigment lines which appear as cross nervures.

"*Genotype: Phlepsius costomaculatus* (Van Duzee)."

Face elongate, crown convex, forewing appendix well developed, outer anteapical cell long and slender, nearly as long as middle anteapical cell; male plates with few spine-like setae on lateral margins in single row; connective stout Y-shaped; aedeagus asymmetrical, shaft slender with distal part bent abruptly sinistro-ventrad, gonopore terminal, pygofer setose.

The Species of *Tropicanus* DeLong

125. *Tropicanus costomaculatus* (Van Duzee)

Allygus costomaculatus Van Duzee, Buffalo Nat. Sci. Bull. 5, 1894, p. 207.
Phlepsius pulchripennis Baker, Ent. News, vol. 9, 1898, p. 65.

Resembling the Phlepsiuslike species in body form and coloration but with arcuate dash near middle of clavus; plates with apical third contracted laterally and incised at base of contraction.

Genitalia: Female seventh sternum four sevenths as long as wide, lateral margins converging from base, posterior lateral angles slightly produced, middle two fifths of posterior margin obtusely produced with slight median notch. Male in lateral view: Pygofer parallelogram in shape, its greatest width half length. Aedeagal base inclined dorsoposteriorly, its length three fifths aedeagal length; aedeagal shaft with basal width of third base length, posteriorly directed a distance of half base length to right angled corner, then dorsoposteriorly from upper corner as a tapering portion to its apical third with an anteriorly curved process. In dorsal view: Aedeagus roundly broad, narrowing on basal third to slender shaft, apical processes lying asymmetrically anterolaterally. Connective shaft Y-shaped with arms converging subapically; shaft widest at arm base, narrowing to an expanded apex.

Types: Lectotype female, Texas, Aaron, designated by P. W. Oman (1946) and syntype female from same place, deposited in the Iowa State College Entomological Collections.

Material studied: (Virginia) Virginia Beach, August 11; (South Carolina) Orangeburg; (Georgia) Folkston, August 2, Decatur County, July 16, Okefenokee Swamp, Peach County, Thomasville; (Florida) Fort Pierce, St. Petersburg, Palm Beach, Lake Placid, Ocala, Montbrook, Leon County, Fort Myers, Fruitville, Suwanee Springs, Fort Lauderdale, Homestead, Cocoanut, Deerfield, Morrison Field, Sanford, Sacoochee, Tallahassee, Elfers, Royal Palm

Park, Marianna, Liberty County, Jacksonville, Lake City, Gainesville, Dunedin, Reddick, Wakullah, LaBelle; (Alabama) Prattsville, July 21; (Mississippi) Meridian, August 13, Fulton, Biloxi, Woodville, July 25, Natchez; (Texas) Cedar Lane, August 9, Jackson County, Rockport, July 5, Booie County, Falfuria, January 1, Sarita, December 25, Elmendorf, July 3; (Kansas) Leavenworth County, June 25.

Notes: Range, in southeastern states and across into Texas. It occurs on herbaceous plants in damp areas in pine woodlands and in everglade hummocks (DeLong 1926).

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PLATE 45

FIG. 1. Dorsoventral view of left fore wing of *Paraphlepsius apertinus* (Osborn and Lathrop).

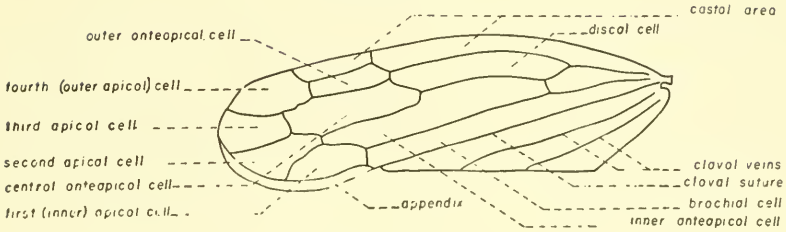
FIG. 2. Lateral view of head of *Paraphlepsius apertinus* (Osborn and Lathrop).

FIG. 3. Anterior view of head of *Paraphlepsius apertinus* (Osborn and Lathrop).

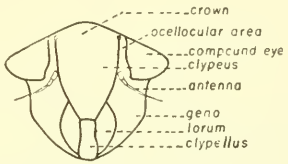
FIG. 4. Dorsoventral view of right hind wing of *Paraphlepsius apertinus* (Osborn and Lathrop).

FIG. 5. Dorsal view of *Paraphlepsius apertinus* (Osborn and Lathrop).

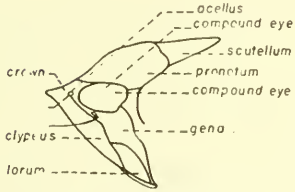
PLATE 45



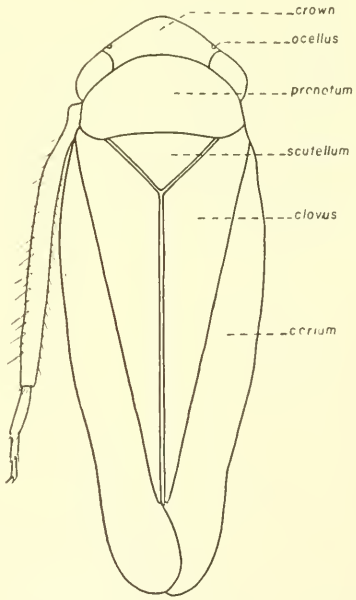
1. LEFT FORE WING



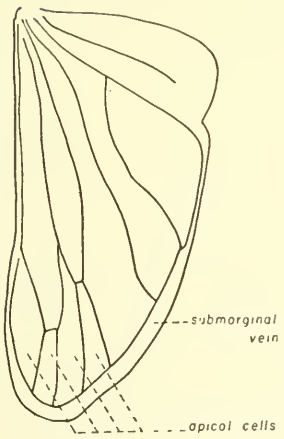
3 HEAD - ANTERIOR VIEW



2. HEAD - LATERAL VIEW



5 BODY - DORSAL VIEW



RIGHT HIND WING

PLATE 46

FIG. 1. Lateral view of male genital capsule of *Texananus* (*Texananus*) *decorus* (Osborn and Ball).

FIG. 2. Dorsal view of aedeagus, connective and right style of *Texananus* (*Texananus*) *decorus* (Osborn and Ball).

FIG. 3. Lateral view of aedeagus and connective of *Paraphlepsius apertinus* (Osborn and Lathrop).

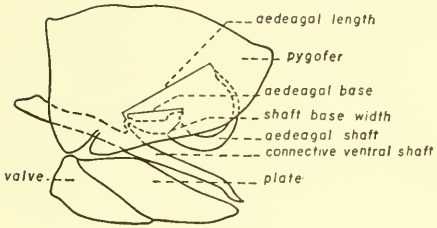
FIG. 4. Lateral view of male genital capsule of *Paraphlepsius apertinus* (Osborn and Lathrop).

FIG. 5. Dorsal view of aedeagus, connective, and right style of *Paraphlepsius apertinus* (Osborn and Lathrop).

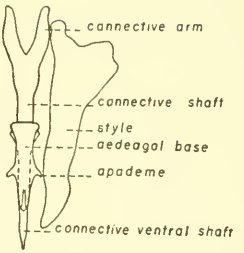
FIG. 6. Ventral view of male genital capsule of *Paraphlepsius apertinus* (Osborn and Lathrop).

FIG. 7. Ventral view of female genital capsule and seventh sternum of *Paraphlepsius apertinus* (Osborn and Lathrop).

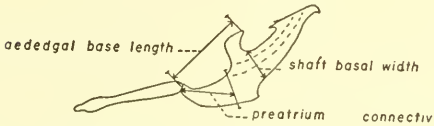
PLATE 46



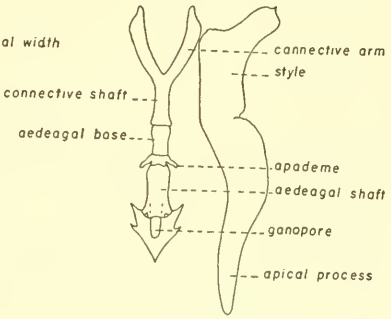
1. MALE GENITALIA - LATERAL VIEW



2. MALE GENITALIA - DORSAL VIEW



3. AEDEAGUS - LATERAL VIEW



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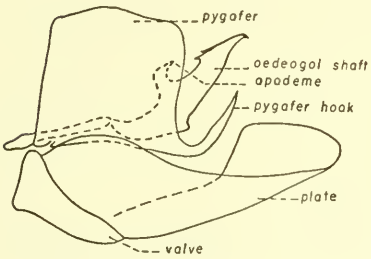
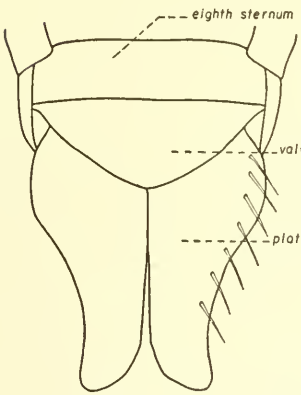
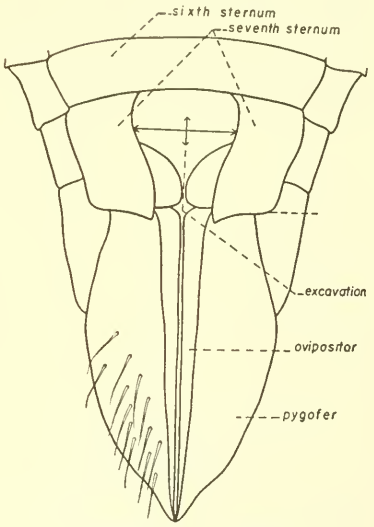


4. MALE GENITALIA - LATERAL VIEW



6. MALE GENITALIA - VENTRAL VIEW



7. FEMALE GENITALIA - VENTRAL VIEW

PLATE 47

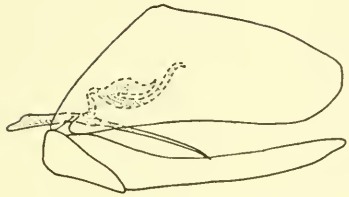
FIG. 1. Lateral view of male genital capsule of *Texananus* (*Texananus*) *ultratus DeLong;* 1a, dorsal view of adeagus, connective, and right style; 1b, ventral view of valve and plates.

FIG. 2. Lateral view of male genital capsule of *Texananus* (*Texananus*) *spatulatus* (Van Duzee); 2a, dorsal view of aedeagus, connective, and right style; 2b, ventral view of valve and plates.

FIG. 3. Lateral view of male genital capsule of *Texananus* (*Texananus*) *sabinus* (Sanders and DeLong); 3a, dorsal view of aedeagus, connective, and right style; 3b, ventral view of valve and plates.

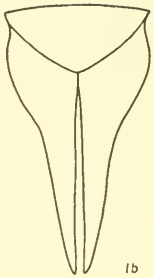
FIG. 4. Lateral view of male genital capsule of *Texananus* (*Texananus*) *personatus* (Baker); 4a, dorsal view of aedeagus, connective, and right style; 4b, ventral view of valve and plates.

PLATE 47

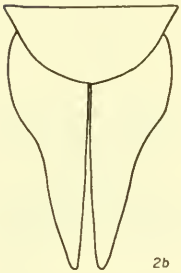


1. T. (Tex.) ultratus

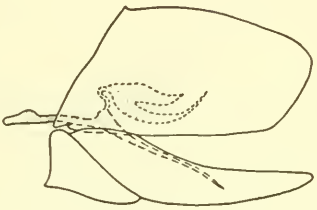
1a



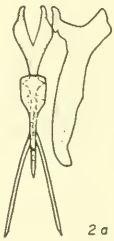
1b



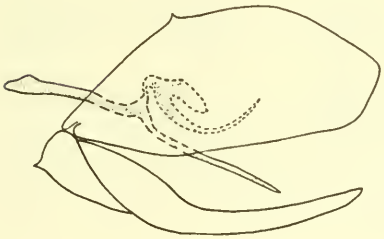
2b



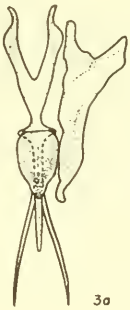
2. T. (Tex.) spatulatus



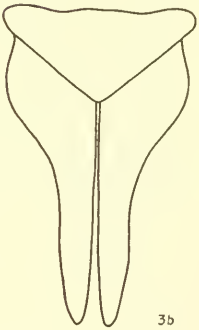
2a



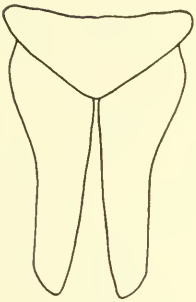
3. T. (Tex.) sabinus



3a

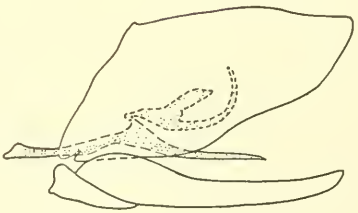


3b



4b

4a



4 T. (Tex.) personatus

PLATE 48

FIG. 5. Lateral view of male genital capsule of *Texananus* (*Texananus*) *rufusculus* (Osborn and Lathrop); 5a, dorsal view of aedeagus, connective, and right style; 5b, ventral view of valve and plates.

FIG. 6. Lateral view of male genital capsule of *Texananus* (*Texananus*) *vermiculatus* DeLong; 6a, dorsal view of aedeagus, connective, and right style; 6b, ventral view of valve and plates.

FIG. 7. Lateral view of male genital capsule of *Texananus* (*Texananus*) *oregonus* (Ball); 7a, dorsal view of aedeagus, connective, and right style; 7b, ventral view of valve and plates.

FIG. 8. Lateral view of male genital capsule of *Texananus* (*Texananus*) *angus* DeLong; 8a, dorsal view of aedeagus, connective, and right style; 8b, ventral view of valve and plates.

FIG. 9. Lateral view of male genital capsule of *Texananus* (*Texananus*) *superbus* (Van Duzee); 9a, dorsal view of aedeagus, connective, and right style; 9b, ventral view of valve and plates.

PLATE 48

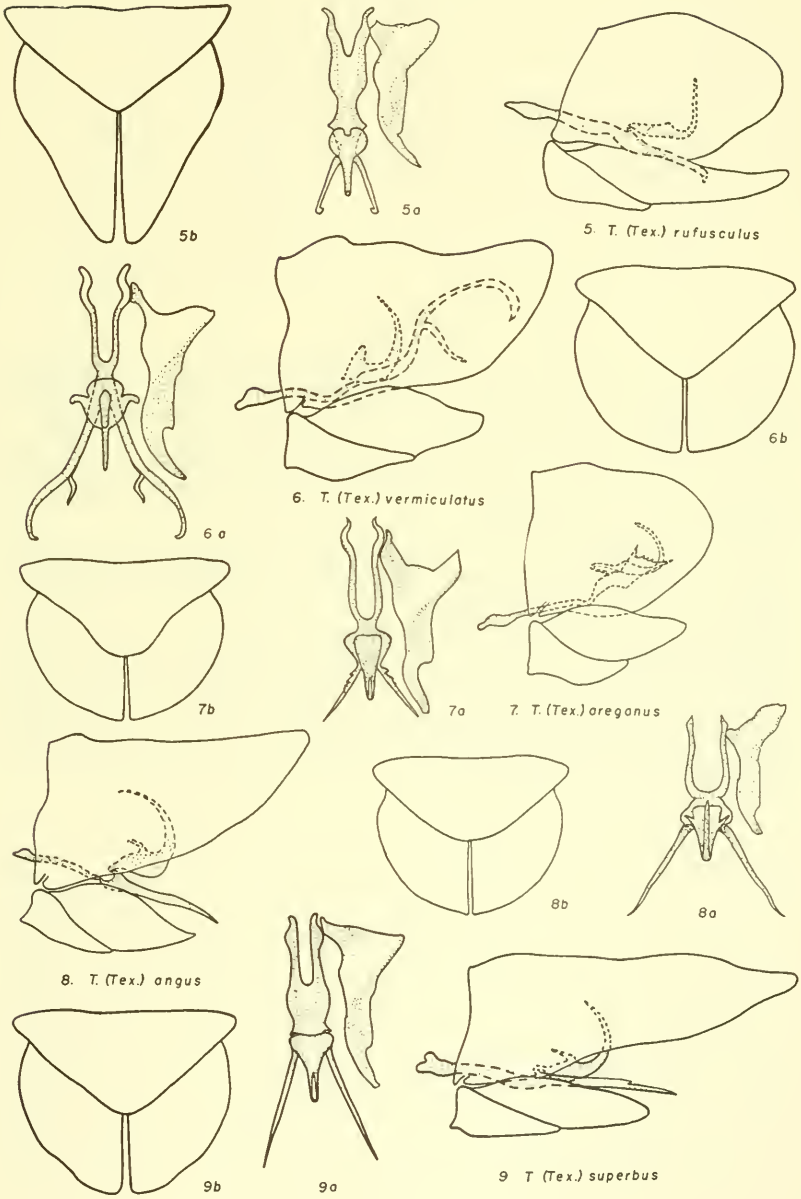

5b
5a
5. T. (Tex.) rufusculus
6 a
6. T. (Tex.) vermiculatus
6b
7b
7a
7. T. (Tex.) areganus
8. T. (Tex.) angus
8b
8a
9b
9a
9 T (Tex.) superbus

PLATE 49

FIG. 10. Lateral view of male genital capsule of *Texananus* (*Texananus*) *lathropi* (Baker); 10a, dorsal view of aedeagus, connective, and right style; 10b, ventral view of valve and plates.

FIG. 11. Lateral view of male genital capsule of *Texananus* (*Texananus*) *extensus* n. sp.; 11a, dorsal view of aedeagus, connective, and right style; 11b, ventral view of valve and plates.

FIG. 12. Lateral view of male genital capsule of *Texananus* (*Texananus*) *mexicanus* (Ball); 12a, dorsal view of aedeagus, connective, and right style; 12b, ventral view of valve and plates.

FIG. 13. Lateral view of male genital capsule of *Texananus* (*Texananus*) *latipex* DeLong; 13a, dorsal view of aedeagus, connective, and right style; 13b, ventral view of valve and plates.

FIG. 14. Lateral view of male genital capsule of *Texananus* (*Texananus*) *arcolatus* (Baker); 14a, dorsal view of aedeagus, connective, and right style; 14b, ventral view of valve and plates.

PLATE 49

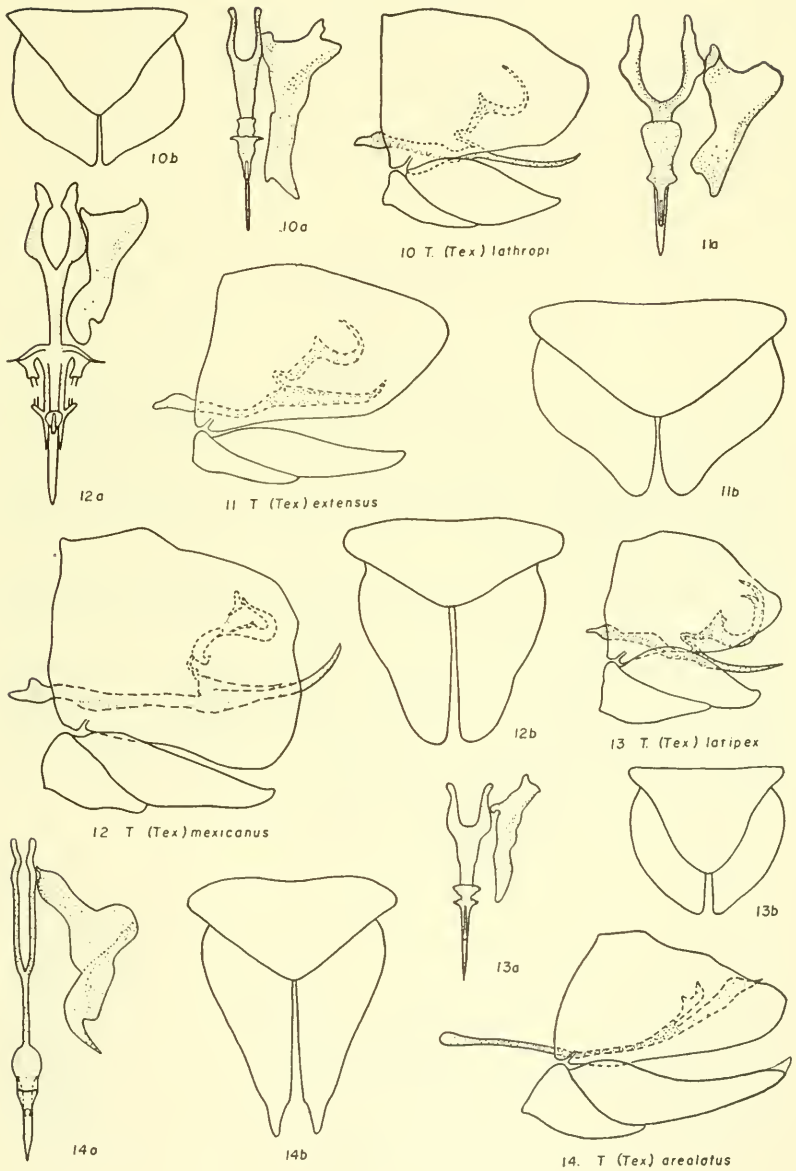

10b
10a
10 T. (Tex.) lathropi
11a
12a
11 T. (Tex.) extensus
11b
12 T. (Tex.) mexicanus
12b
13 T. (Tex.) latipex
13b
13a
14a
14b
14. T. (Tex.) arealatus

PLATE 50

FIG. 15. Lateral view of male genital capsule of *Texananus* (*Texananus*) *extremus* (Ball); 15a, dorsal view of aedeagus, connective, and right style; 15b, ventral view of valve and plates.

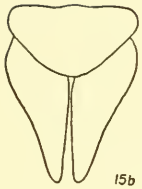
FIG. 16. Lateral view of male genital capsule of *Texananus* (*Texananus*) *fumosus,* n. sp.; 16a, dorsal view of aedeagus, connective, and right style; 16b, ventral view of valve and plates.

FIG. 17. Lateral view of male genital capsule of *Texananus* (*Texananus*) *dolus* DeLong; 17a, dorsal view of aedeagus, connective, and right style; 17b, ventral view of valve and plates.

FIG. 18. Lateral view of aedeagus and connective of *Texananus* (*Texananus*) *sonorus* Ball; 18a, dorsal view of right style.

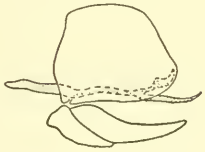
FIG. 19. Lateral view of male genital capsule of *Texananus* (*Texananus*) *decorus* (Osborn and Ball); 19a, dorsal view of aedeagus, connective, and right style; 19b ventral view of valve and plates.

PLATE 50

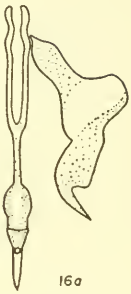


15b

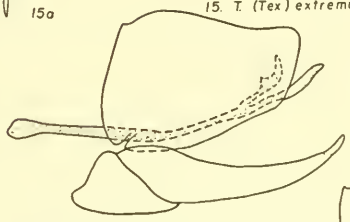
15a



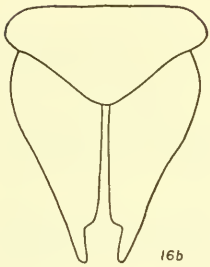
15. T. (Tex.) extremus



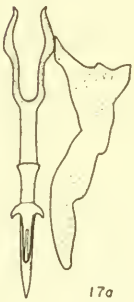
16a



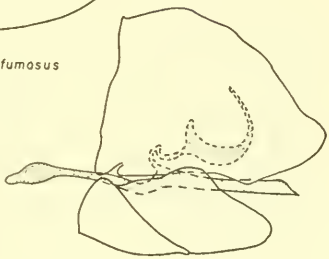
16. T. (Tex.) fumosus



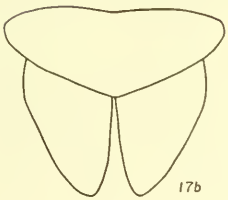
16b



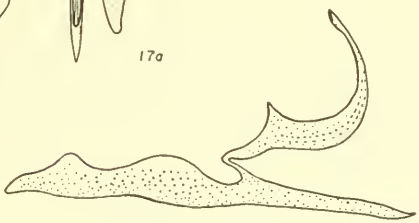
17a



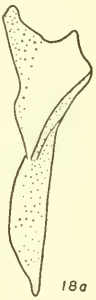
17. T. (Tex.) dolus



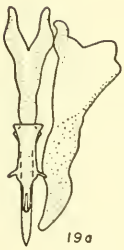
17b



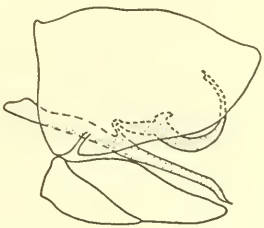
18. T. (Tex.) sonorus



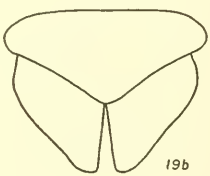
18a



19a



19. T. (Tex.) decorus



19b

PLATE 51

FIG. 20. Lateral view of male genital capsule of *Texananus* (*Texananus*) *deversus* DeLong and Hershberger; 20a, dorsal view of aedeagus, connective, and right style; 20b, ventral view of valve and plates.

FIG. 21. Lateral view of male genital capsule of *Texananus* (*Texananus*) *pergradus* DeLong; 21a, dorsal view of aedeagus, connective, and right style; 21b, ventral view of valve and plates.

FIG. 22. Lateral view of male genital capsule of *Texananus* (*Texananus*) *ovatus* (Van Duzee); 22a, dorsal view of aedeagus, connective, and right style; 22b, ventral view of valve and plates.

FIG. 23. Lateral view of male genital capsule of *Texananus* (*Texananus*) *ovatus* subsp. *distinctus* (Lathrop); 23a, dorsal view of aedeagus, connective, and right style; 23b, ventral view of valve and plates.

FIG. 24. Lateral view of male genital tapsule of *Texananus* (*Texananus*) *sextus* n. sp.; 24a, dorsal view of aedeagus, connective, and right style; 24b, ventral view of valve and plates.

FIG. 25. Lateral view of male genital capsule of *Texananus* (*Texananus*) *gladius* DeLong; 25a, dorsal view of aedeagus, connective, and right style; 25b, ventral view of valve and plates.

PLATE 51

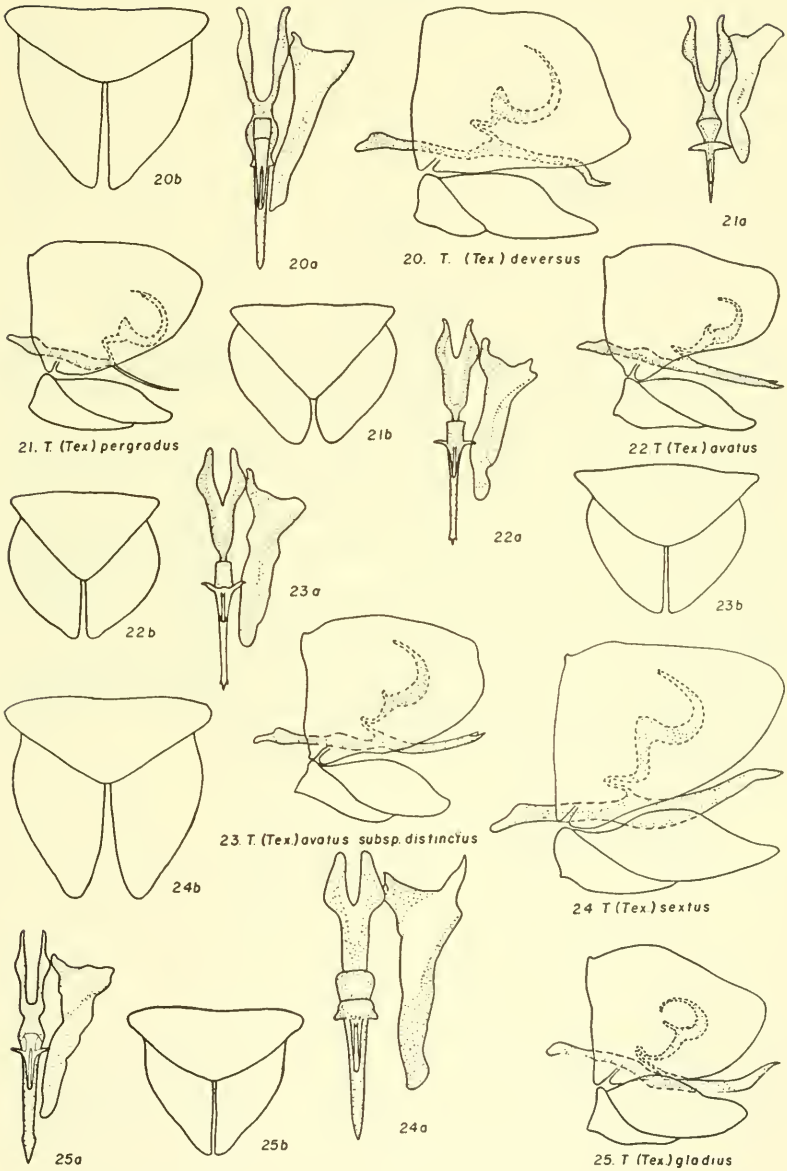

20b
20a
20. T. (Tex.) deversus
21a
21. T. (Tex.) pergradus
21b
22 T (Tex.) avatus
22a
22b
23a
23b
23. T. (Tex.) avatus subsp. distinctus
24 T (Tex.) sextus
24b
24a
25a
25b
25. T. (Tex.) gladius

PLATE 52

FIG. 26. Lateral view of male genital capsule of *Texananus* (*Texananus*) *denticulus* (Osborn and Lathrop); 26a, dorsal view of aedeagus, connective, and right style; 26b, ventral view of valve and plates.

FIG. 27. Lateral view of male genital capsule of *Texananus* (*Texananus*) *graphicus* (Ball); 27a, dorsal view of aedeagus, connective, and right style; 27b, ventral view of valve and plates.

FIG. 28. Lateral view of male genital capsule of *Texananus* (*Texananus*) *constrictus* n. sp.; 28a, dorsal view of aedeagus, connective, and right style; 28b, ventral view of valve and plates.

FIG. 29. Lateral view of male genital capsule of *Texananus* (*Texananus*) *marmor* (Sanders and DeLong); 29a, dorsal view of aedeagus, connective, and right style; 29b, ventral view of valve and plates.

FIG. 30. Lateral view of male genital capsule of *Texananus* (*Texananus*) *cumulatus* (Ball); 30a, dorsal view of aedeagus, connective, and right style; 30b, ventral view of valve and plates.

PLATE 52

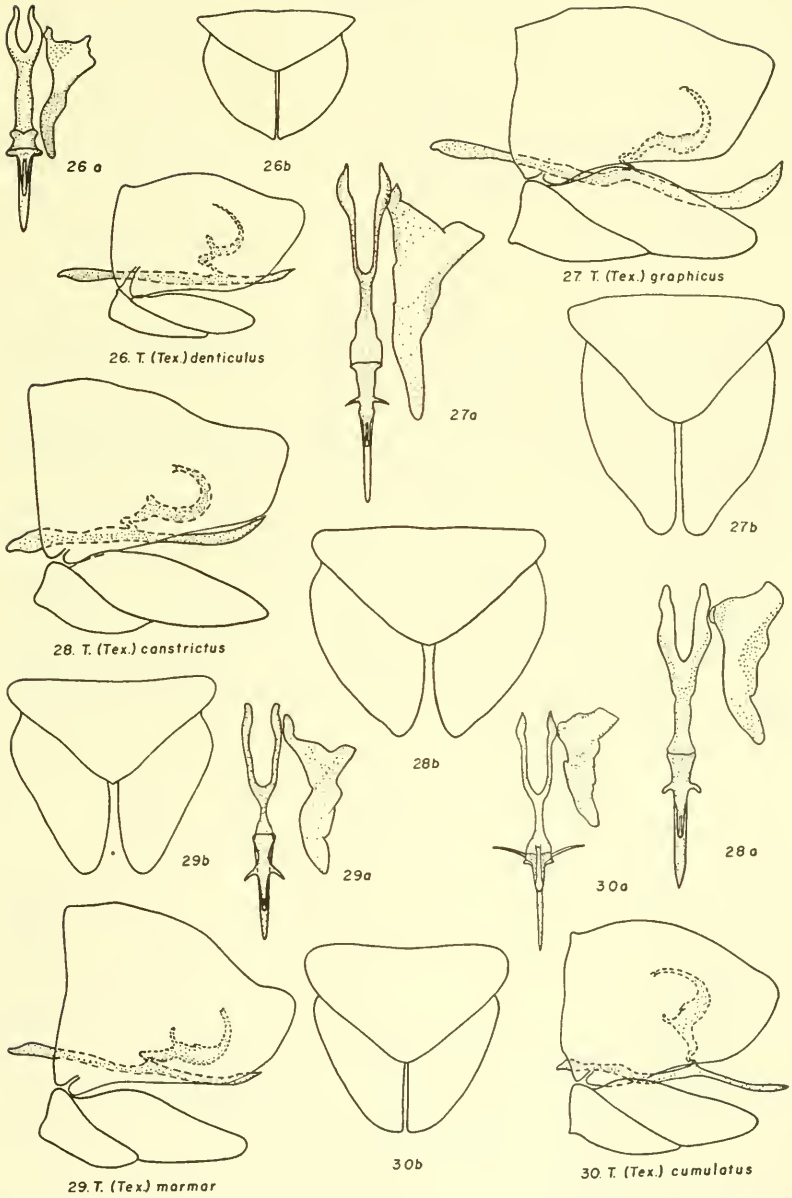

26 a
26b
26. T. (Tex.) denticulus
27. T. (Tex.) graphicus
27a
27b
28. T. (Tex.) canstrictus
28b
28a
29b
29a
30a
29. T. (Tex.) marmar
30b
30. T. (Tex.) cumulatus

PLATE 53

FIG. 31. Lateral view of the male genital capsule of *Texananus* (*Texananus*) *arctostaphylae* (Ball); 31a, dorsal view of aedeagus, connective, and right style; 31b, ventral view of valve and plates.

FIG. 32. Lateral view of male genital capsule of *Texananus* (*Texananus*) *monticolus* DeLong; 32a, dorsal view of aedeagus, connective, and right style; 32b, ventral view of valve and plates.

FIG. 33. Lateral view of male genital capsule of *Texananus* (*Texananus*) *proximus* n. sp.; 33a, dorsal view of aedeagus, connective, and right style; 33b, ventral view of valve and plates.

FIG. 34. Lateral view of male genital capsule of *Texananus* (*Texananus*) *bialtus* DeLong; 34a, dorsal view of aedeagus, connective, and right style; 34b, ventral view of valve and plates.

FIG. 35. Lateral view of male genital capsule of *Texananus* (*Texananus*) *validus* n. sp.; 35a, dorsal view of aedeagus, connective, and right style; 35b, ventral view of valve and plates.

PLATE 53

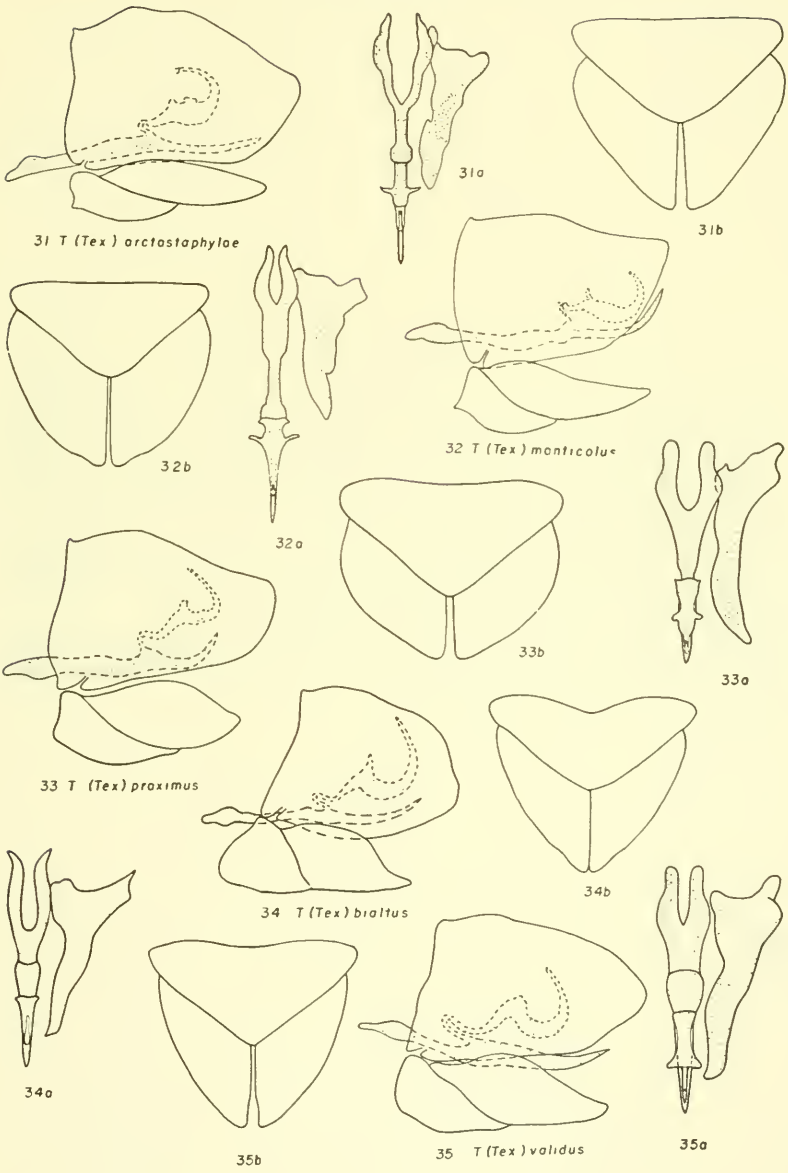

31 T (Tex) orctostaphylae
31a
31b
32b
32a
32 T (Tex) monticolus
33b
33a
33 T (Tex) proximus
34 T (Tex) bialtus
34b
34a
35b
35 T (Tex) validus
35a

PLATE 54

FIG. 36. Lateral view of male genital capsule of *Texananus* (*Excultanus*) *dorothyi* DeLong; 36a, dorsal view of aedeagus, connective, and right style; 36b, ventral view of valve and plates.

FIG. 37. Lateral view of male genital capsule of *Texananus* (*Excultanus*) *excultus* (Uhler); 37a, dorsal view of aedeagus, connective, and right style; 37b, ventral view of valve and plates.

FIG. 38. Lateral view of male genital capsule of *Texananus* (*Excultanus*) *incurvatus* (Osborn and Lathrop); 38a, dorsal view of aedeagus, connective, and right style; 38b, ventral view of valve and plates.

FIG. 39. Lateral view of male genital capsule of *Texananus* (*Excultanus*) *neomexicanus* (Baker); 39a, dorsal view of aedeagus, connective, and right style; 39b, ventral view of valve and plates.

PLATE 54

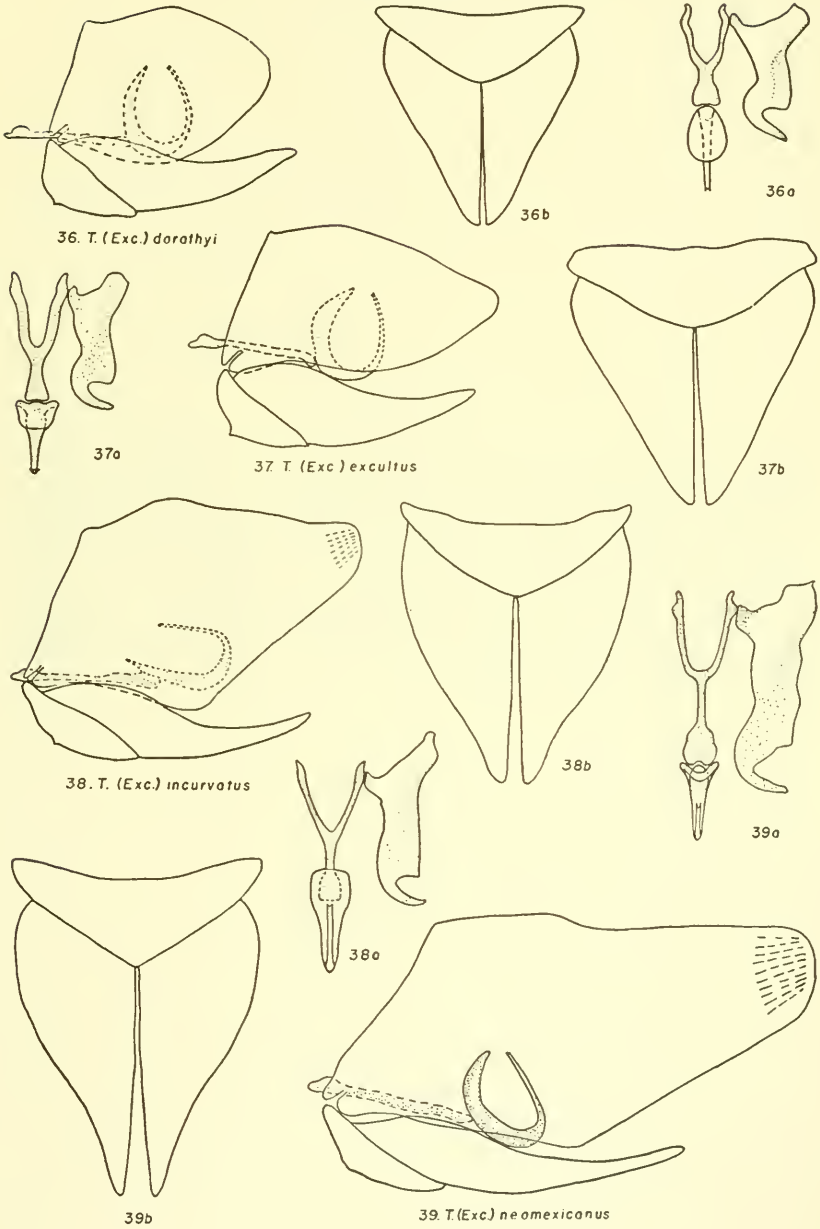

36. T. (Exc.) dorathyi
36b
36a
37a
37. T. (Exc.) excultus
37b
38. T. (Exc.) incurvatus
38b
39a
38a
39b
39. T. (Exc.) neomexicanus

PLATE 55

FIG. 40. Lateral view of male genital capsule of *Texananus* (*Iowanus*) *lyratus* (DeLong and Hershberger); 40a, dorsal view of aedeagus, connective, and right style; 40b, ventral view of valve and plates.

FIG. 41. Lateral view of male genital capsule of *Texananus* (*Iowanus*) *majestus* (Osborn and Ball); 41a, dorsal view of aedeagus, connective, and right style; 40b, ventral view of valve and plates.

FIG. 42. Lateral view of male genital capsule of *Texananus* (*Iowanus*) *dicentrus* DeLong; 42a, dorsal view of aedeagus, connective, and right style; 42b, ventral view of valve and plates.

PLATE 55

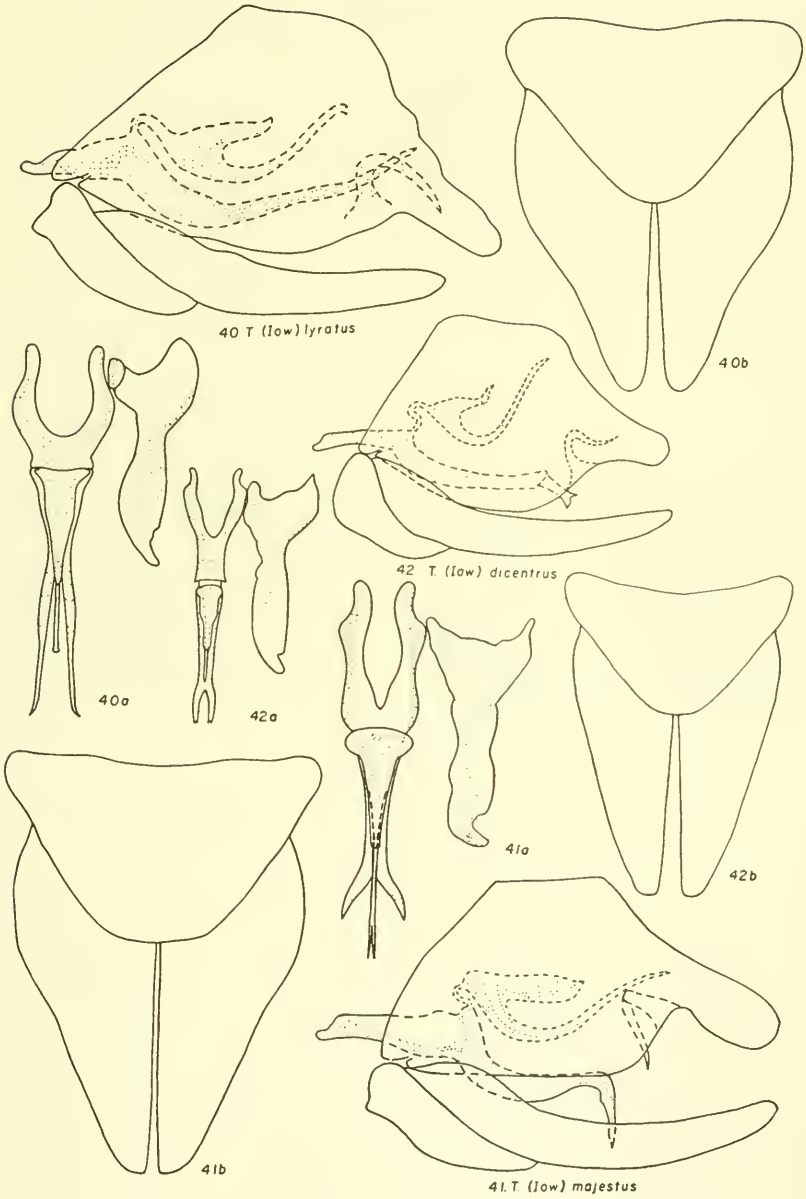

40 T (low) lyratus
40b
42 T (low) dicentrus
40a
42a
41a
42b
41b
41 T (low) majestus

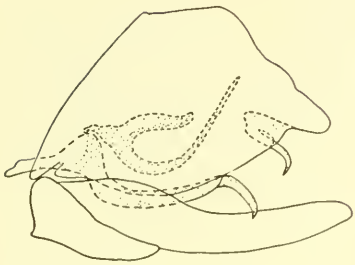
PLATE 56

FIG. 43. Lateral view of male genital capsule of *Texananus* (*Iowanus*) *caducus* DeLong; 43a, dorsal view of aedeagus, connective, and right style; 43b, ventral view of valve and plates.

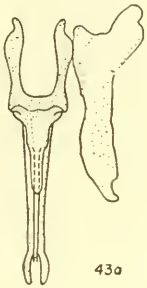
FIG. 44. Lateral view of male genital capsule of *Texananus* (*Iowanus*) *bullatus* DeLong; 44a, dorsal view of aedeagus, connective, and right style; 44b, ventral view of valve and plates.

FIG. 45. Lateral view of male genital capsule of *Texananus* (*Iowanus*) *longipennis* n. sp.; 45a, dorsal view of aedeagus, connective, and right style; 45b, ventral view of valve and plates.

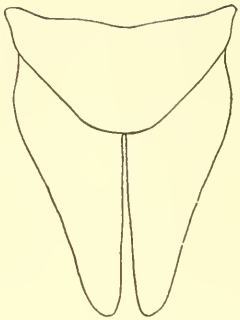
PLATE 56



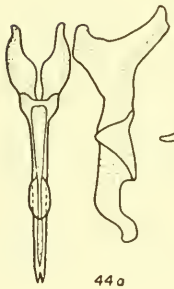
43. T. (low) caducus



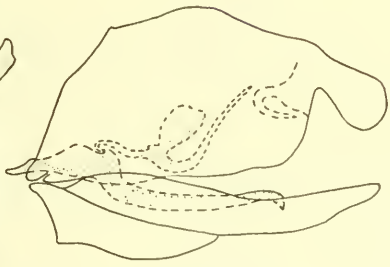
43a



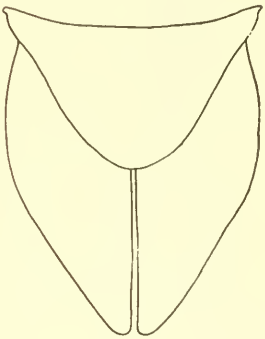
43b



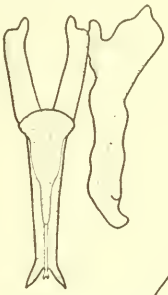
44a



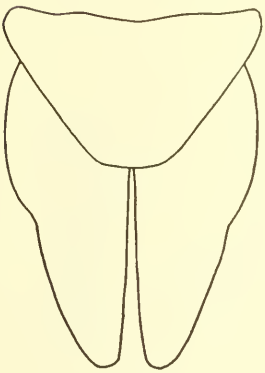
44 T. (low) bullotus



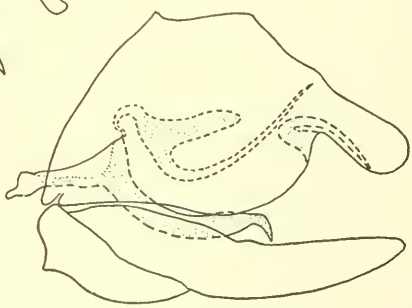
44b



45a



45b



45 T. (low.) longipennis

PLATE 57

FIG. 46. Lateral view of male genital capsule of *Paraphlepsius nudus* (Ball); 46a, dorsal view of aedeagus, connective, and right style; 46b, ventral view of valve and plates.

FIG. 47. Lateral view of male genital capsule of *Paraphlepsius cinereus* (Van Duzee); 47a, dorsal view of aedeagus, connective, and right style; 47b, ventral view of valve and plates.

FIG. 48. Lateral view of male genital capsule of *Paraphlepsius truncatus* (Van Duzee); 48a, dorsal view of aedeagus, connective, and right style; 48b, ventral view of valve and plates.

FIG. 49. Lateral view of male genital capsule of *Paraphlepsius texanus* (Baker); 49a, dorsal view of aedeagus, connective, and right style; 49b, ventral view of valve and plates.

FIG. 50. Lateral view of male genital capsule of *Paraphlepsius electus* (DeLong); 50a, dorsal view of aedeagus, connective, and right style; 50b, ventral view of valve and plates.

PLATE 57

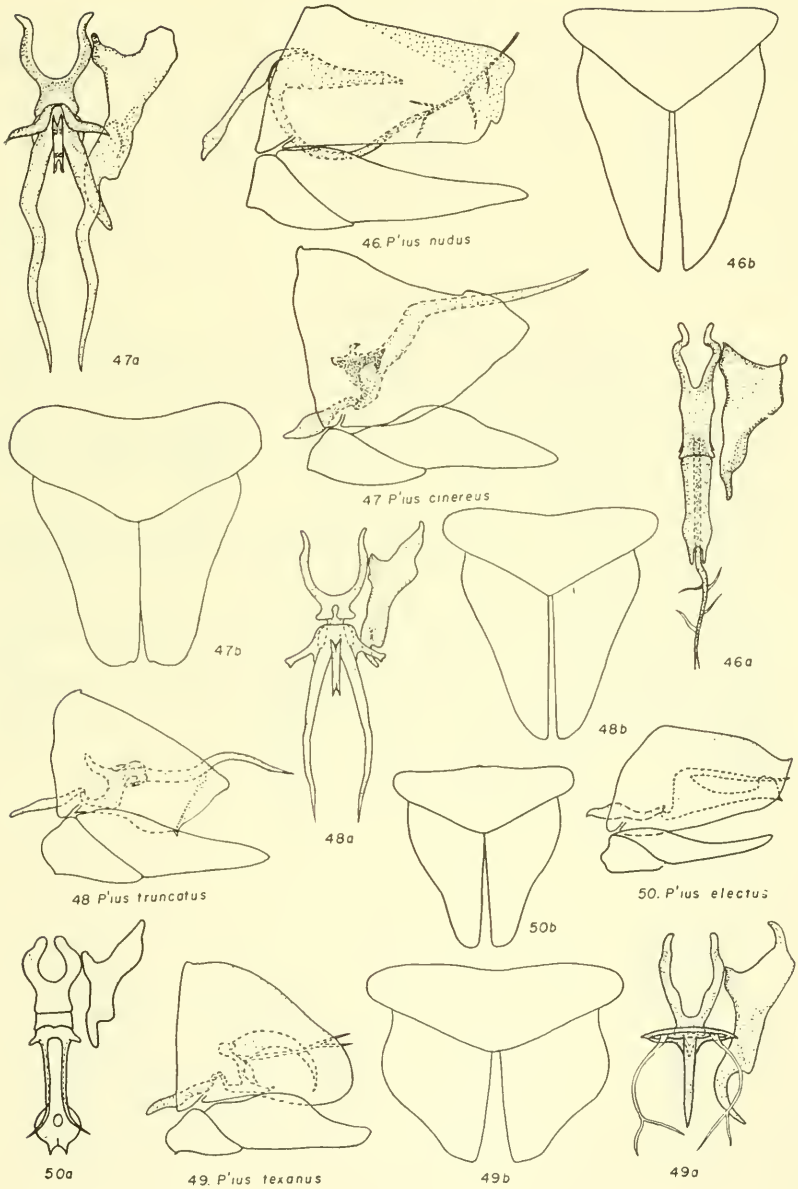

47a
46. P'ius nudus
46b
47 P'ius cinereus
47b
46a
48a
48b
48 P'ius truncatus
50. P'ius electus
50b
50a
49. P'ius texanus
49b
49a

PLATE 58

FIG. 51. Lateral view of male genital capsule of *Paraphlepsius planus* (Sanders and DeLong); 51a, dorsal view of aedeagus, connective, and right style; 51b, ventral view of valve and plates.

FIG. 52. Lateral view of male genital capsule of *Paraphlepsius cornutus* n. sp.; 52a, dorsal view of aedeagus, connective, and right style; 52b, ventral view of valve and plates.

FIG. 53. Lateral view of male genital capsule of *Paraphlepsius floridanus* (Ball); 53a, dorsal view of aedeagus, connective, and right style; 53b, ventral view of valve and plates.

FIG. 54. Lateral view of male genital capsule of *Paraphlepsius lascivius* (Ball); 54a, dorsal view of aedeagus, connective, and right style; 54b, ventral view of valve and plates.

FIG. 55. Lateral view of male genital capsule of *Paraphlepsius bipartitus* (DeLong); 55a, dorsal view of aedeagus, connective, and right style; 55b, ventral view of valve and plates.

PLATE 58

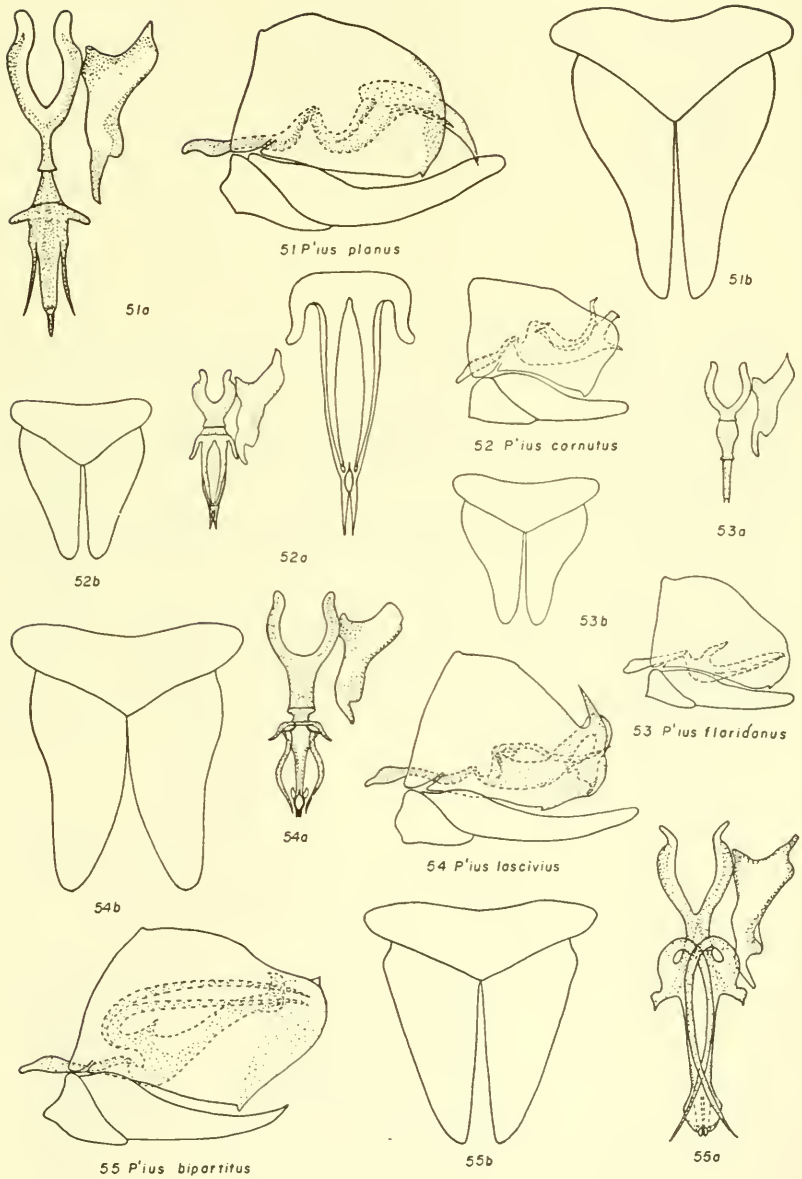

51a
51 P'ius planus
51b
52a
52 P'ius cornutus
52b
53a
53b
53 P'ius floridanus
54a
54 P'ius lascivius
54b
55 P'ius bipartitus
55b
55a

PLATE 59

FIG. 56. Lateral view of male genital capsule of *Paraphlepsius tubus* (Ball); 56a, dorsal view of aedeagus, connective, and right style; 56b, ventral view of valve and plates.

FIG. 57. Lateral view of male genital capsule of *Paraphlepsius lobatus* (Osborn); 57a, dorsal view of aedeagus, connective, and right style; 57b, ventral view of valve and plates.

FIG. 58. Lateral view of male genital capsule of *Paraphlepsius torridus* (Lathrop); 58a, dorsal view of aedeagus, connective, and right of style; 58b, ventral view of valve and plates.

FIG. 59. Lateral view of male genital capsule of *Paraphlepsius umbrosus* (Sanders and DeLong); 59a, dorsal view of aedeagus, connective, and right style; 59b, ventral view of valve and plates.

FIG. 60. Lateral view of male genital capsule of *Paraphlepsius collitus* (Ball); 60a, dorsal view of aedeagus, connective, and right style; 60b, ventral view of valve and plates.

PLATE 59

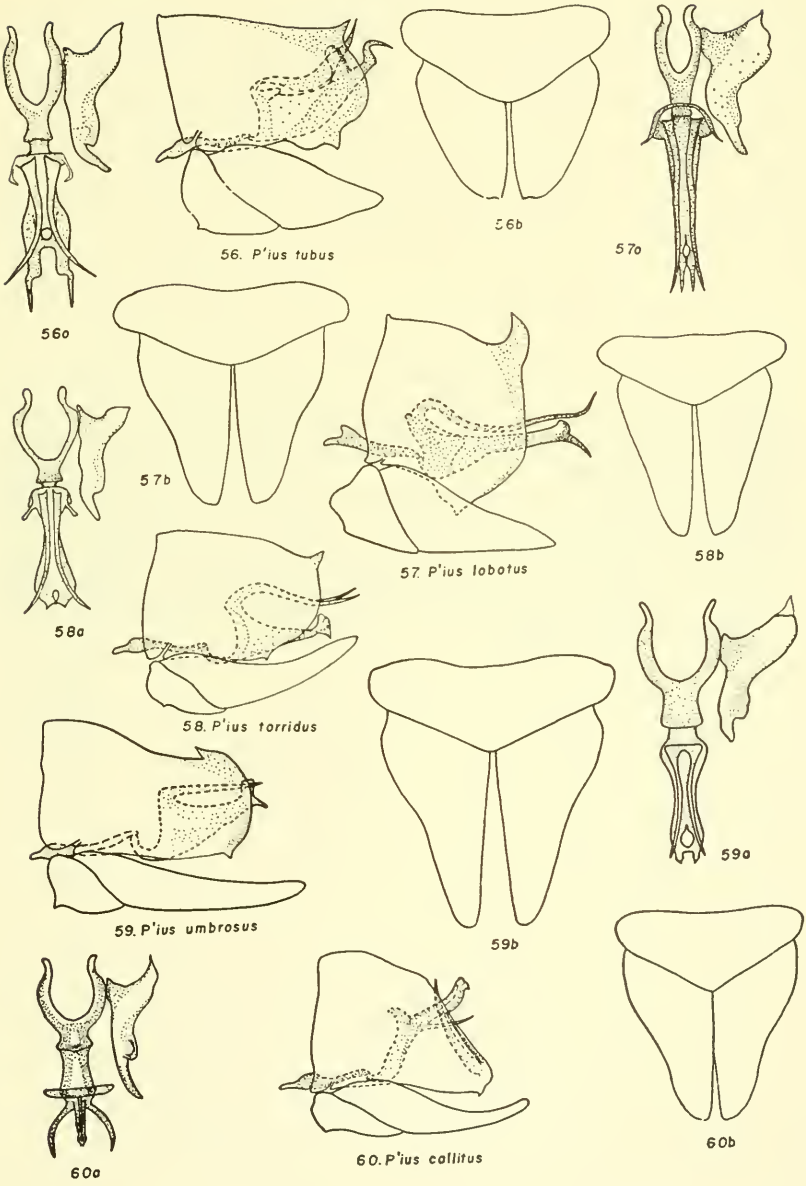

56a
56. P'ius tubus
56b
57a
57b
57. P'ius lobotus
58a
58b
58. P'ius torridus
59. P'ius umbrosus
59a
59b
60a
60. P'ius callitus
60b

PLATE 60

FIG. 61. Lateral view of male genital capsule of *Paraphlepsius attractus* (Ball); 61a, dorsal view of aedeagus, connective, and right style; 61b, ventral view of valve and plates.

FIG. 62. Lateral view of male genital capsule of *Paraphlepsius solidaginis* (Walker); 62a, dorsal view of aedeagus, connective, and right style; 62b, ventral view of valve and plates.

FIG. 63. Lateral view of male genital capsule of *Paraphlepsius humidus* (Van Duzee); 63a, dorsal view of aedeagus, connective, and right style; 63b, ventral view of valve and plates.

PLATE 60

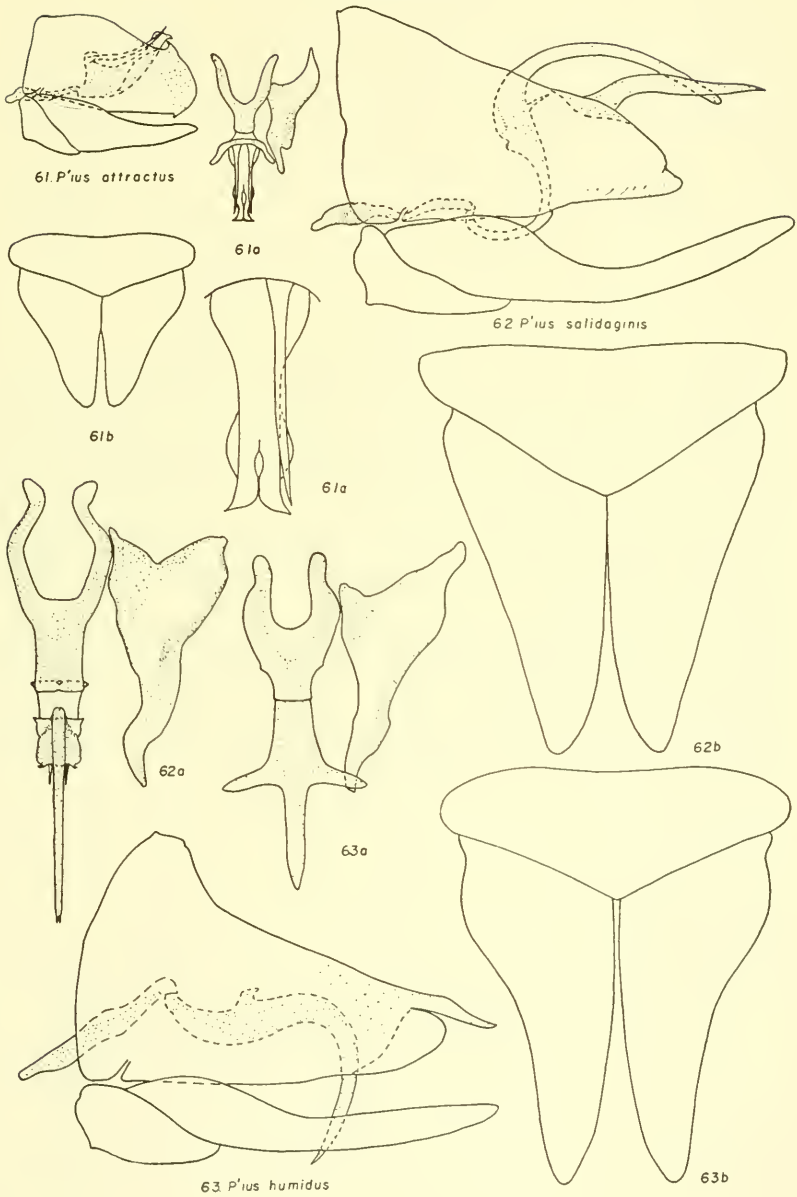

61. P'ius attractus
61a
62 P'ius salidaginis
61b
61a
62b
62a
63a
63b
63 P'ius humidus

PLATE 61

FIG. 64. Lateral view of male genital capsule of *Paraphlepsius carolinus* (Lathrop); 64a, dorsal view of aedeagus, connective, and right style; 64b, ventral view of valve and plates.

FIG. 65. Lateral view of male genital capsule of *Paraphlepsius optatus* (Crumb); 65a, dorsal view of aedeagus, connective, and right style; 65b, ventral view of valve and plates.

FIG. 66. Lateral view of male genital capsule of *Paraphlepsius pusillus* (Baker); 66a, dorsal view of aedeagus, connective, and right style; 66b, ventral view of valve and plates.

FIG. 67. Lateral view of male genital capsule of *Paraphlepsius occidentalis* (Baker); 67a, dorsal view of aedeagus, connective, and right style; 67b, ventral view of valve and plates.

FIG. 68. Lateral view of male genital capsule of *Paraphlepsius eburneolus* (Osborn and Lathrop); 68a, dorsal view of aedeagus, connective, and right style; 68b, ventral view of valve and plates.

PLATE 61

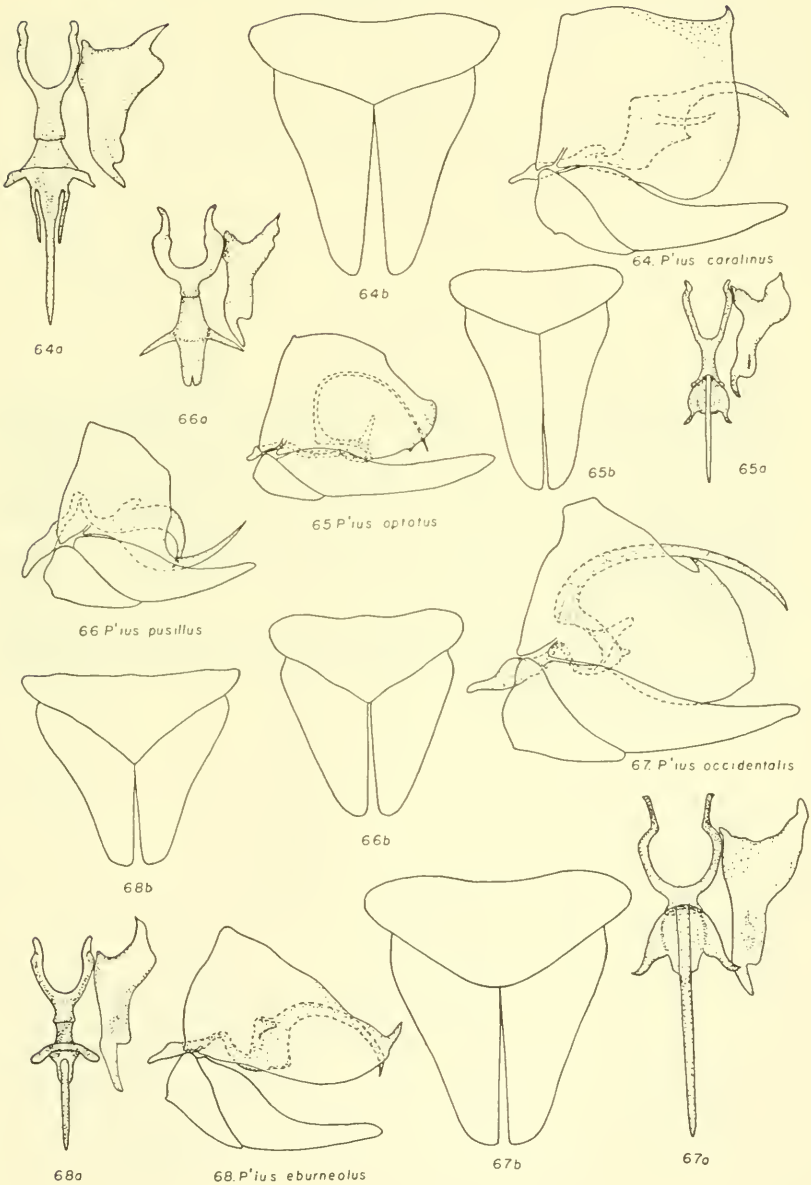

64a
64b
64. P'ius caralinus
66a
65b
65a
65 P'ius optatus
66 P'ius pusillus
67. P'ius occidentalis
66b
68b
68a
68. P'ius eburneolus
67b
67a

PLATE 62

FIG. 69. Lateral view of male genital capsule of *Paraphlepsius apertinus* (Osborn and Lathrop); 69a, dorsal view of aedeagus, connective, and right style; 69b, ventral view of valve and plates.

FIG. 70. Lateral view of male genital capsule of *Paraphlepsius excavatus* n. sp.; 70a, dorsal view of aedeagus, connective, and right style; 70b, ventral view of valve and plates.

FIG. 71. Lateral view of male genital capsule of *Paraphlepsius acutus* n. sp.; 71a, dorsal view of aedeagus, connective, and right style; 71b, ventral view of valve and plates.

FIG. 72. Lateral view of male genital capsule of *Paraphlepsius apertus* (Van Duzee); 72a, dorsal view of aedeagus, connective, and right style; 72b, ventral view of valve and plates.

PLATE 62

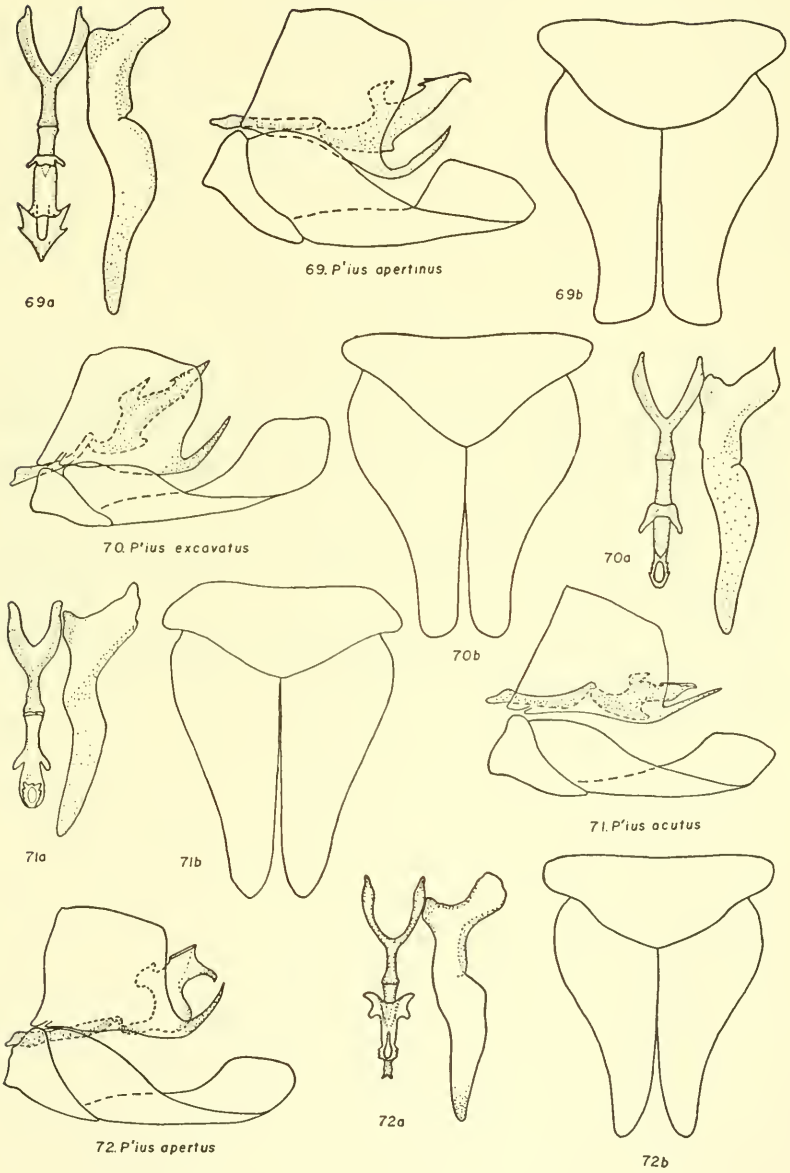

69a
69. P'ius apertinus
69b
70. P'ius excavatus
70b
70a
71a
71b
71. P'ius acutus
72. P'ius apertus
72a
72b

PLATE 63

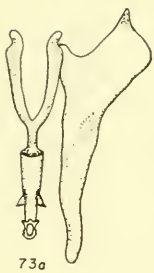
FIG. 73. Lateral view of male genital capsule of *Paraphlepsius irroratus* (Say); 73a, dorsal view of aedeagus, connective, and right style; 73b, ventral view of valve and plates.

FIG. 74. Lateral view of male genital capsule of *Paraphlepsius altus* (Osborn and Ball); 74a, dorsal view of aedeagus, connective, and right style; 74b, ventral view of valve and plates.

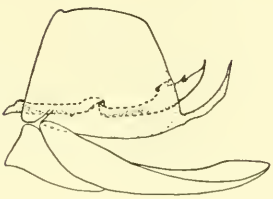
FIG. 75. Lateral view of male genital capsule of *Paraphlepsius fulvidorsum* (Fitch); 75a, dorsal view of aedeagus, connective, and right style; 75b, ventral view of valve and plates.

FIG. 76. Lateral view of male genital capsule of *Paraphlepsius tennessa* (DeLong); 76a, dorsal view of aedeagus, connective, and right style; 76b, ventral view of valve and plates.

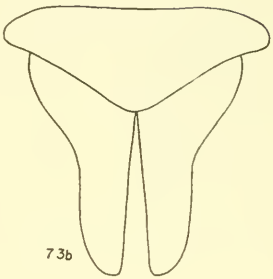
PLATE 63



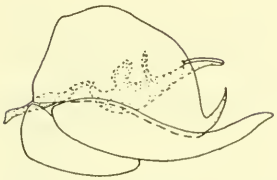
73a



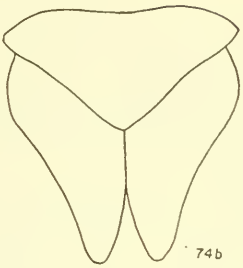
73. P'ius irraratus



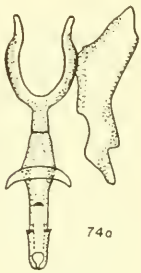
73b



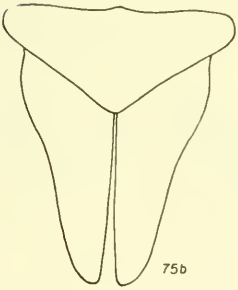
74. P'ius altus



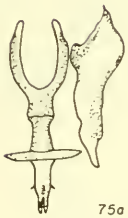
74b



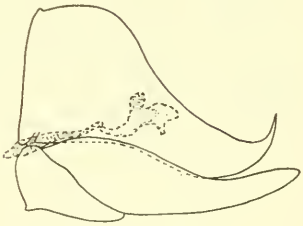
74a



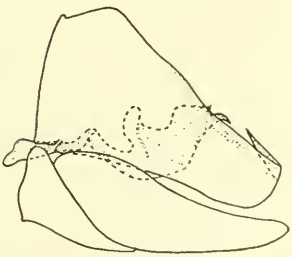
75b



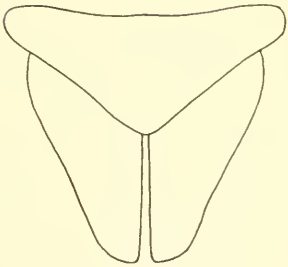
75a



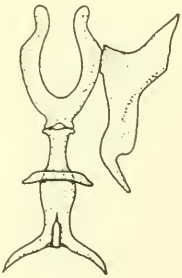
75. P'ius fulvidarsum



76 P'ius tennessa



76b



76a

PLATE 64

FIG. 77. Lateral view of the male genital capsule of *Paraphlepsius maculellus* (Osborn); 77a, dorsal view of aedeagus, connective, and right style; 77b, ventral view of valve and plates.

FIG. 78. Lateral view of male genital capsule of *Paraphlepsius certus* (DeLong); 78a, dorsal view of aedeagus, connective, and right style; 78b, ventral view of valve and plates.

FIG. 79. Lateral view of male genital capsule of *Paraphlepsius dentatus* (Baker); 79a, dorsal view of aedeagus, connective, and right style; 79b, ventral view of valve and plates.

FIG. 80. Lateral view of male genital capsule of *Paraphlepsius hemicolor* (Sanders and DeLong); 80a, dorsal view of aedeagus, connective, and right style; 80b, ventral view of valve and plates.

FIG. 81. Lateral view of male genital capsule of *Paraphlepsius tigrinus* (Ball); 81a, dorsal view of aedeagus, connective, and right style; 81b, ventral view of valve and plates.

PLATE 64

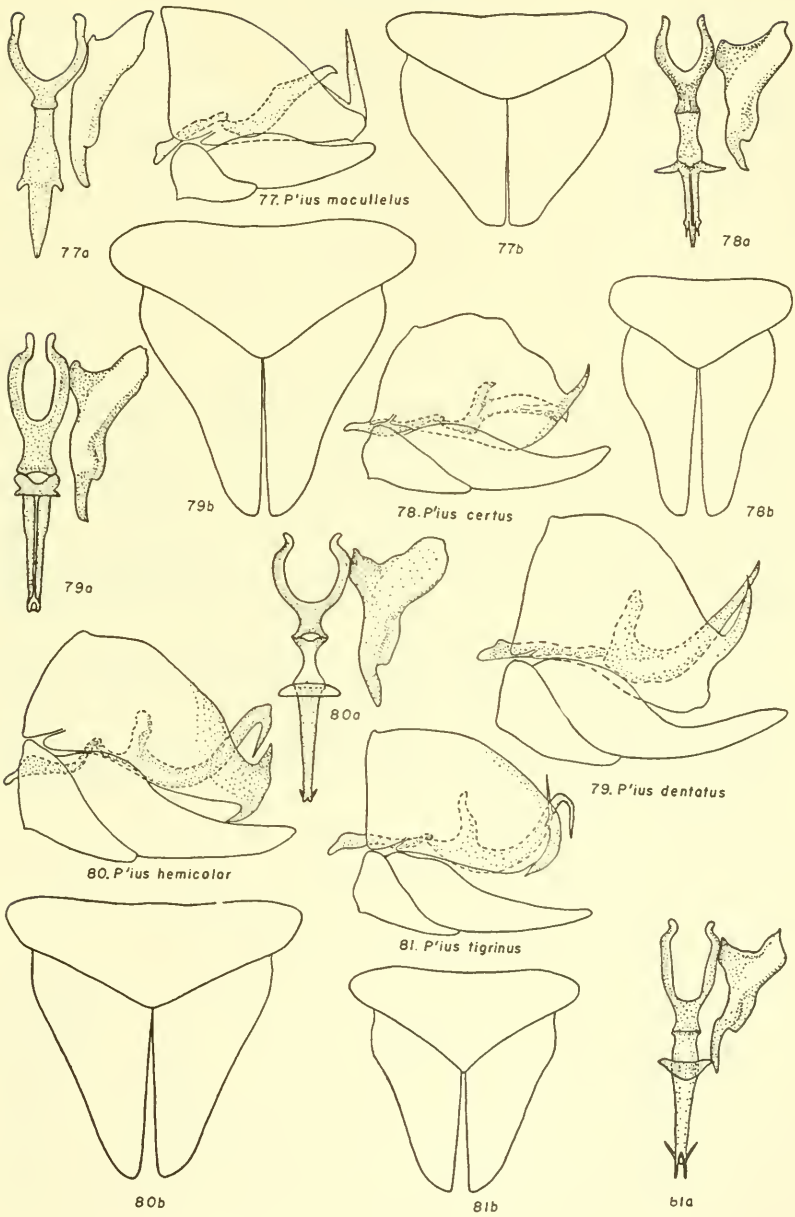

77. P'ius maculielus
77a
77b
78a
79b
78. P'ius certus
78b
79a
80a
79. P'ius dentatus
80. P'ius hemicolor
81. P'ius tigrinus
80b
81b
81a

PLATE 65

FIG. 82. Lateral view of male genital capsule of *Paraphlepsius rossi* (DeLong); 82a, dorsal view of aedeagus, connective, and right style; 82b, ventral view of valve and plates.

FIG. 83. Lateral view of male genital capsule of *Paraphlepsius palustris* (Sanders and DeLong); 83a, dorsal view of aedeagus, connective, and right style; 83b, ventral view of valve and plates.

FIG. 84. Lateral view of male genital capsule of *Paraphlepsius lippulus* (Ball); 84a, dorsal view of aedeagus, connective, and right style; 84b, ventral view of valve and plates.

FIG. 85. Lateral view of male genital capsule of *Paraphlepsius strobi* (Fitch); 85a, dorsal view of aedeagus, connective, and right style; 85b, ventral view of valve and plates.

FIG. 86. Lateral view of male genital capsule of *Paraphlepsius spinosus* n. sp.; 86a, dorsal view of aedeagus, connective, and right style; 86b, ventral view of valve and plates.

PLATE 65

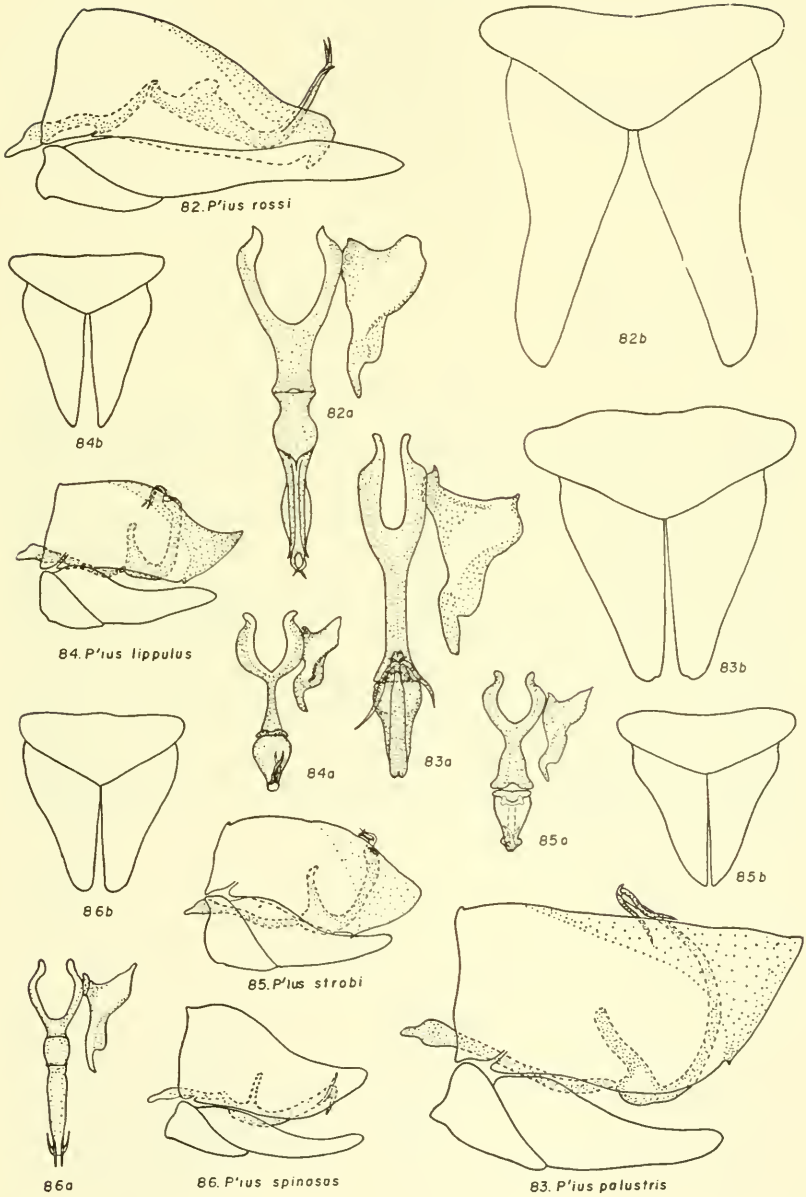

82. P'ius rossi
82b
84b
82a
84. P'ius lippulus
84a
83a
83b
85a
85b
86b
85. P'ius strobi
86a
86. P'ius spinosas
83. P'ius palustris

PLATE 66

FIG. 87. Lateral view of male genital capsule of *Paraphlepsius supinus* (DeLong); 87a, dorsal view of aedeagus, connective, and right style; 87b, ventral view of valve and plates.

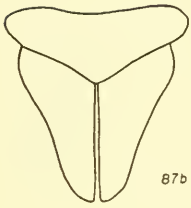
FIG. 88. Lateral view of male genital capsule of *Paraphlepsius avicephalus* n. sp.; 88a, dorsal view of aedeagus, connective, and right style; 88b, ventral view of valve and plates.

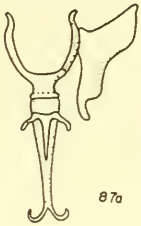
FIG. 89. Lateral view of male genital capsule of *Paraphlepsius punctiscriptus* (Van Duzee); 89a, dorsal view of aedeagus, connective, and right style; 89b, ventral view of valve and plates.

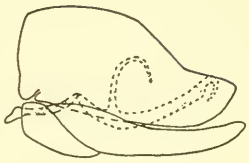
FIG. 90. Lateral view of male genital capsule of *Paraphlepsius slossonae* (Ball); 90a, dorsal view of aedeagus, connective, and right style; 90b, ventral view of valve and plates.

FIG. 91. Lateral view of male genital capsule of *Paraphlepsius tullahoma* (DeLong); 91a, dorsal view of aedeagus, connective, and right style; 91b, ventral view of valve and plates.

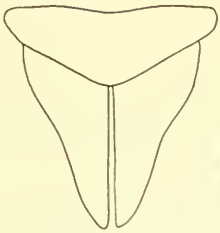
PLATE 66

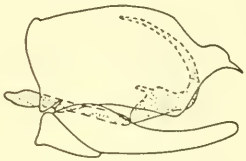

87b


87a

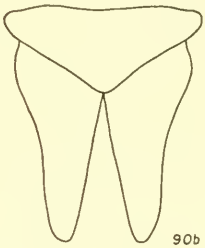

87. P'ius supinus

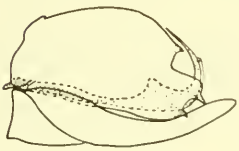
88a

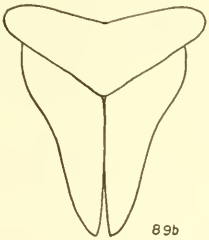

88b


88. P'ius ovicepholus

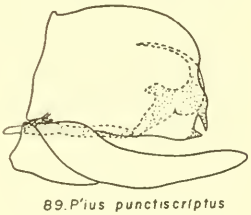
90a

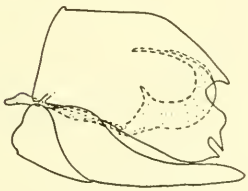

90b


90. P'ius slossonae


89b

89a


89. P'ius punctiscriptus


91. P'ius tullahoma

91a

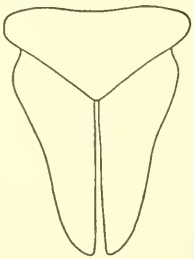

91b

PLATE 67

FIG. 92. Lateral view of male genital capsule of *Paraphlepsius obvius* (Oman); 92a, dorsal view of aedeagus, connective, and right style; 92b, ventral view of valve and plates.

FIG. 93. Lateral view of male genital capsule of *Paraphlepsius emarginatus* n. sp.; 93a, dorsal view of aedeagus, connective, and right style; 93b, ventral view of valve and plates.

FIG. 94. Lateral view of male genital capsule of *Paraphlepsius maculosus* (Osborn); 94a, dorsal view of aedeagus, connective, and right style; 94b, ventral view of valve and plates.

FIG. 95. Lateral view of male genital capsule of *Paraphlepsius pallidus* (Van Duzee); 95a, dorsal view of aedeagus, connective, and right style; 95b, ventral view of valve and plates.

FIG. 96. Lateral view of male genital capsule of *Paraphlepsius divergens* (Oman); 96a, dorsal view of aedeagus, connective, and right style; 96b, ventral view of valve and plates.

PLATE 67

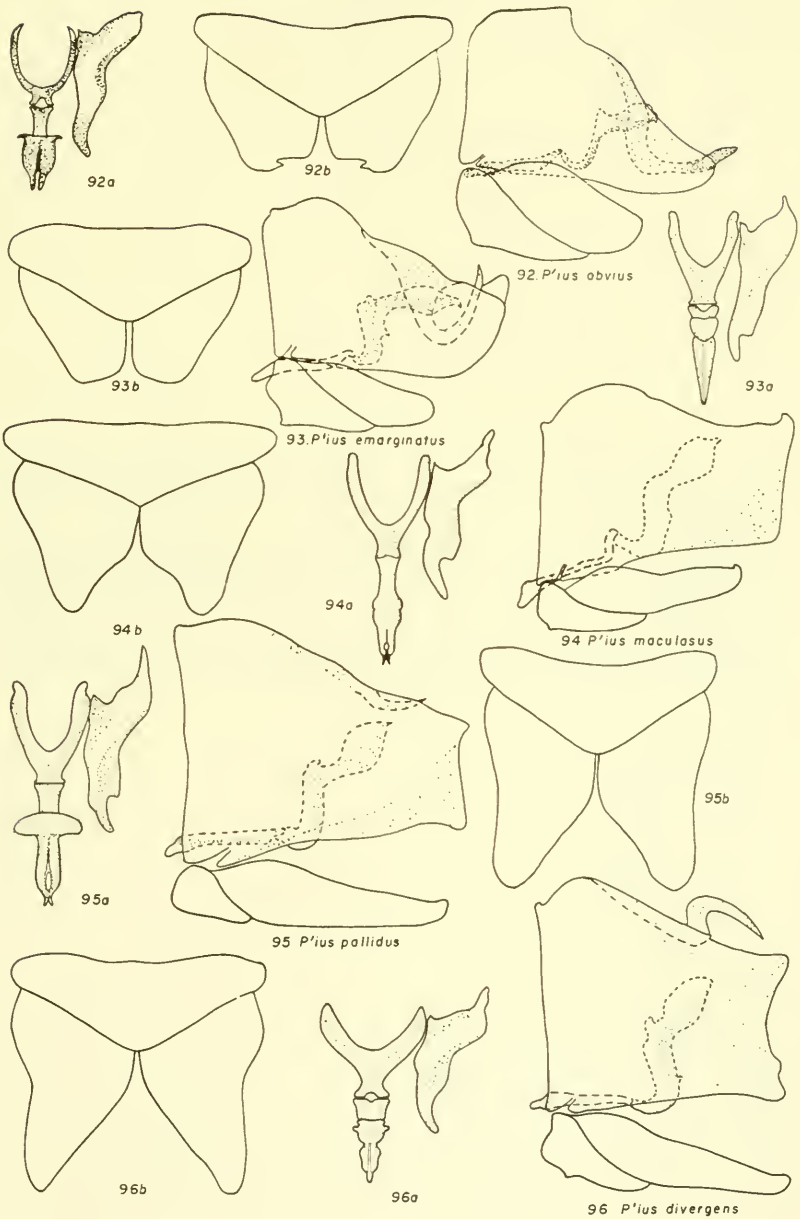

92a
92b
92. P'ius obvius
93b
93. P'ius emarginatus
93a
94b
94a
94 P'ius maculasus
95a
95 P'ius pallidus
95b
96b
96a
96 P'ius divergens

PLATE 68

FIG. 97. Lateral view of male genital capsule of *Paraphlepsius operculatus* (Ball); 97a, dorsal view of aedeagus, connective, and right style; 97b, ventral view of valve and plates.

FIG. 98. Lateral view of male genital capsule of *Paraphlepsius mimus* (Baker); 98a, dorsal view of aedeagus, connective, and right style; 98b, ventral view of valve and plates.

FIG. 99. Lateral view of male genital capsule of *Paraphlepsius bifidus* (Sanders and DeLong); 99a, dorsal view of aedeagus, connective, and right style; 99b, ventral view of valve and plates.

PLATE 68

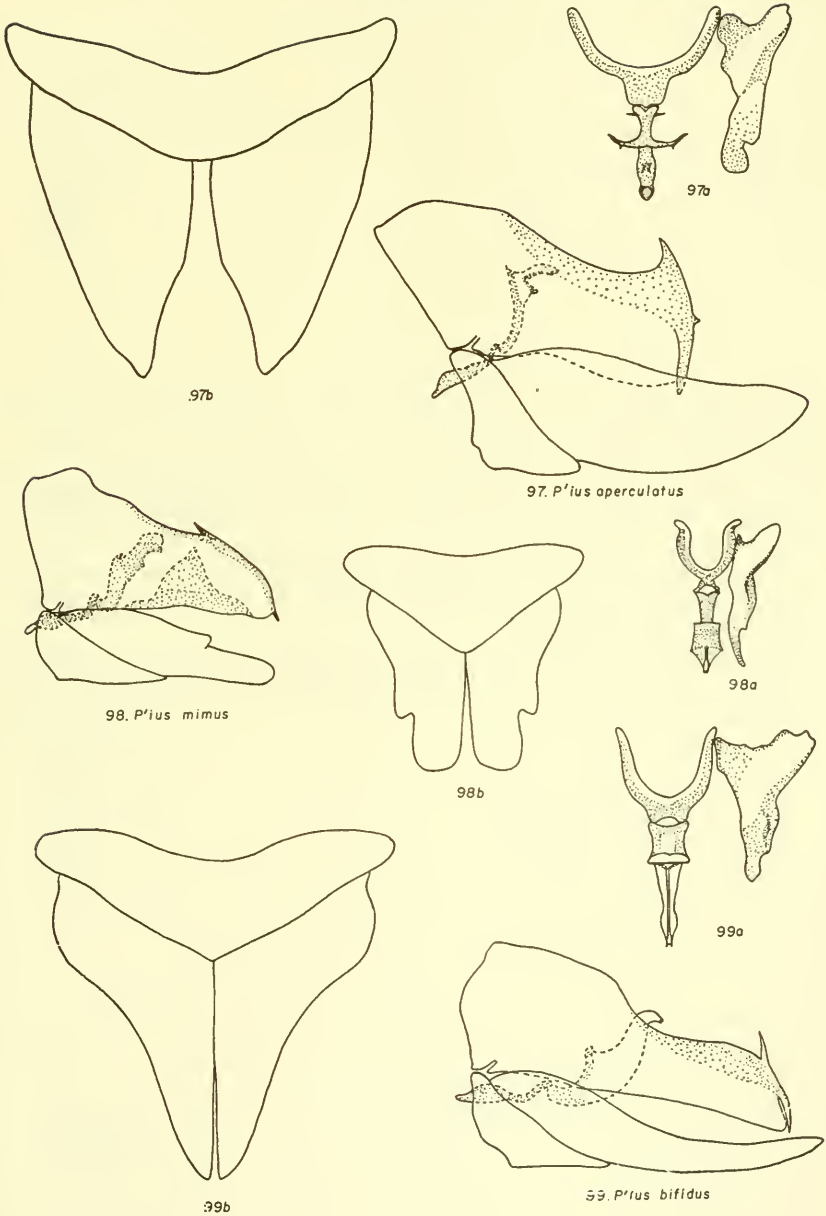

97a
97b
97. P'ius aperculatus
98. P'ius mimus
98a
98b
99a
99b
99. P'ius bifidus

PLATE 69

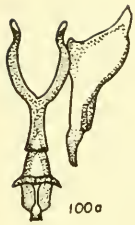
FIG. 100. Lateral view of male genital capsule of *Paraphlepsius turpiculus* (Ball); 100a, dorsal view of aedeagus, connective, and right style; 100b, ventral view of valve and plates.

FIG. 101. Lateral view of male genital capsule of *Paraphlepsius abruptus* (DeLong); 101a, dorsal view of aedeagus, connective, and right style; 101b, ventral view of valve and plates.

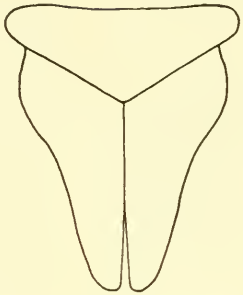
FIG. 102. Lateral view of male genital capsule of *Paraphlepsius continuus* (DeLong); 102a, dorsal view of aedeagus, connective, and right style; 102b, ventral view of valve and plates.

FIG. 103. Lateral view of male genital capsule of *Paraphlepsius siclus* (DeLong); 103a, dorsal view of aedeagus, connective, and right style; 103b, ventral view of valve and plates.

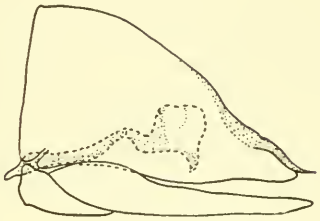
PLATE 69



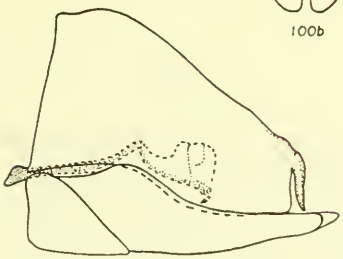
100a



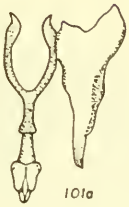
100b



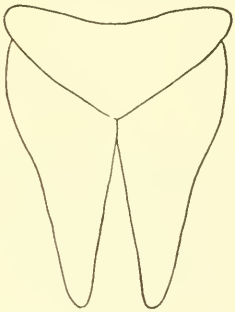
100. P'ius turpiculus



101 P'ius abruptus

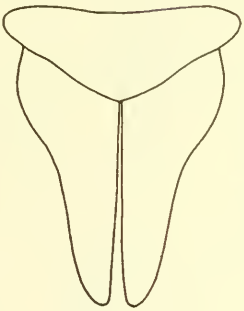


101a

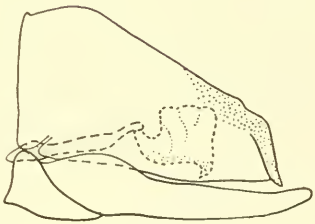


101b

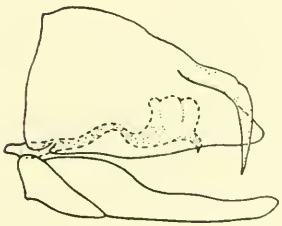
102a



102b

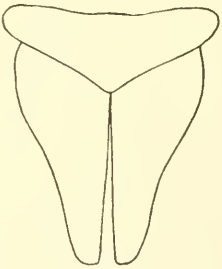


102 P'ius continuus



103. P'ius siclus

103a



103b

PLATE 70

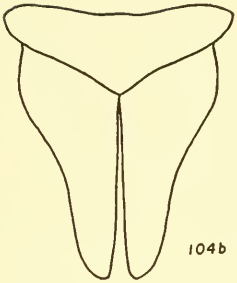
FIG. 104. Lateral view of male genital capsule of *Paraphlepsius fuscipennis* (Van Duzee); 104a, dorsal view of aedeagus, connective, and right style; 104b, ventral view of valve and plates.

FIG. 105. Lateral view of male genital capsule of *Paraphlepsius fuscipennis* var. *seminolus* (DeLong); 105a, dorsal view of aedeagus, connective, and right style; 105b, ventral view of valve and plates.

FIG. 106. Lateral view of male genital capsule of *Paraphlepsius rileyi* (Baker); 106a, dorsal view of aedeagus, connective, and right style; 106b, ventral view of valve and plates.

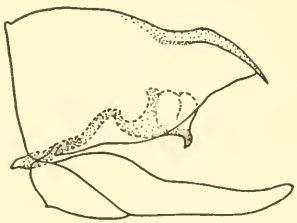
FIG. 107. Lateral view of male genital capsule of *Paraphlepsius incisus* (Van Duzee); 107a, dorsal view of aedeagus, connective, and right style; 107b, ventral view of valve and plates.

PLATE 70

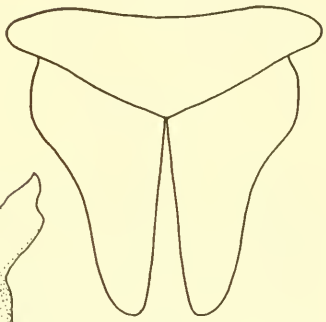


104b

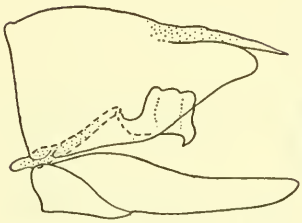
104a



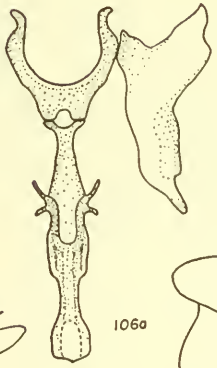
104. P'ius fuscipennis



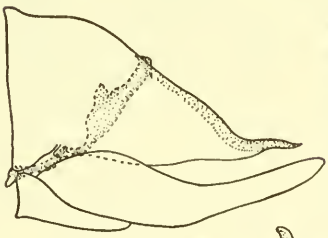
107b



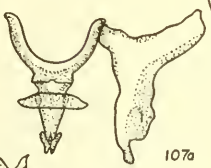
105. P'ius fuscipennis var. seminolus



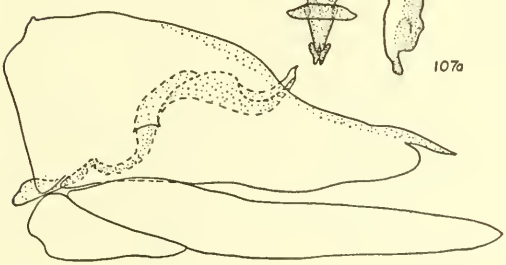
106a



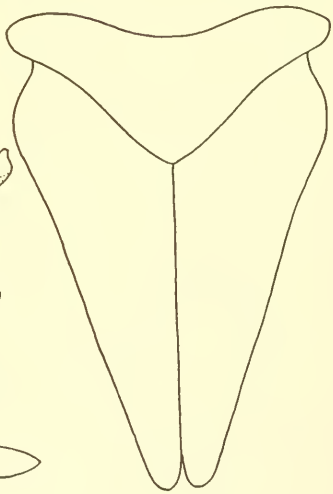
107. P'ius incisus



107a



106. P'ius rileyi



106b

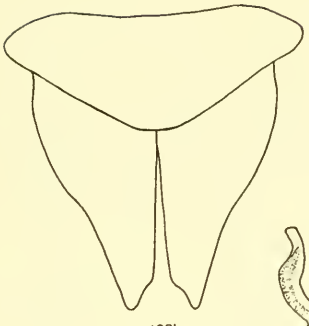
PLATE 71

FIG. 108. Lateral view of male genital capsule of *Paraphlepsius brunneus* (DeLong); 108a, dorsal view of aedeagus, connective, and right style; 108b, ventral view of valve and plates.

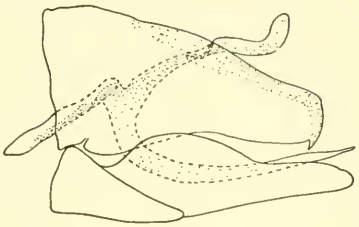
FIG. 109. Lateral view of male genital capsule of *Paraphlepsius latifrons* (Van Duzee); 109a, dorsal view of aedeagus, connective, and right style; 109b, ventral view of valve and plates.

FIG. 110. Lateral view of male genital capsule of *Paraphlepsius particolor* (Sanders and DeLong); 110a, dorsal view of aedeagus, connective, and right style; 110b, ventral view of valve and plates.

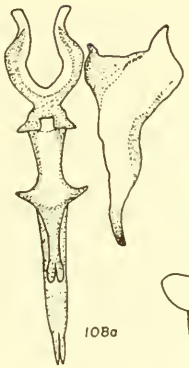
PLATE 71



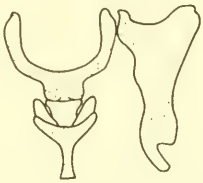
108b



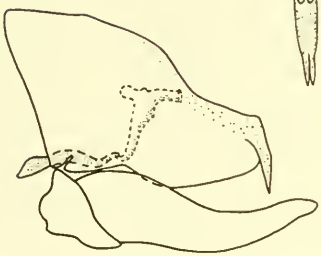
108. P'ius brunneus



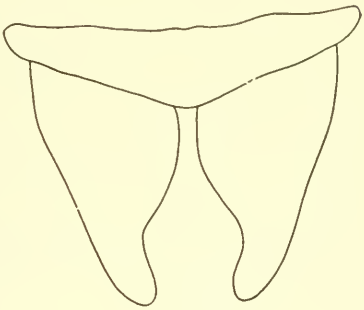
108a



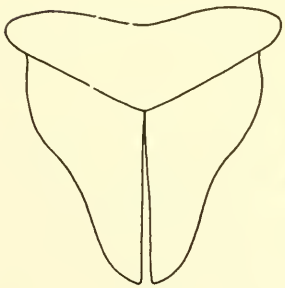
109a



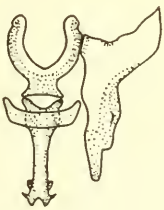
109. P'ius latifrons



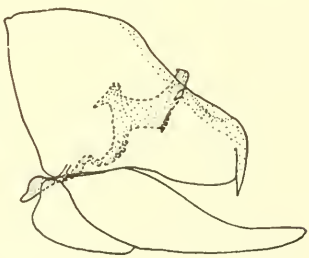
109b



110b



110a



110 P'ius particolor

PLATE 72

FIG. 111. Lateral view of male genital capsule of *Phlepsanus denudatus* (Ball); 111a, dorsal view of aedeagus, connective, and right style; 111b, ventral view of valve and plates.

FIG. 112. Genital parts of *Phlepsanus denudatus* var. *carpolus* apparently as shown in No. 111. (Coloration of wing as the varietal character.)

FIG. 113. Lateral view of male genital capsule of *Phlepsanus angustus* n. sp.; 113a, dorsal view of aedeagus, connective, and right style; 113b, ventral view of valve and plates.

FIG. 114. Lateral view of male genital capsule of *Phlepsanus nigrifrons* (Ball); 114a, dorsal view of aedeagus, connective, and right style; 114b, ventral view of valve and plates.

FIG. 115. Lateral view of male genital capsule of *Phlepsanus tumidatus* n. sp.; 115a, dorsal view of aedeagus, connective, and right style; 115b, ventral view of valve and plates.

PLATE 72

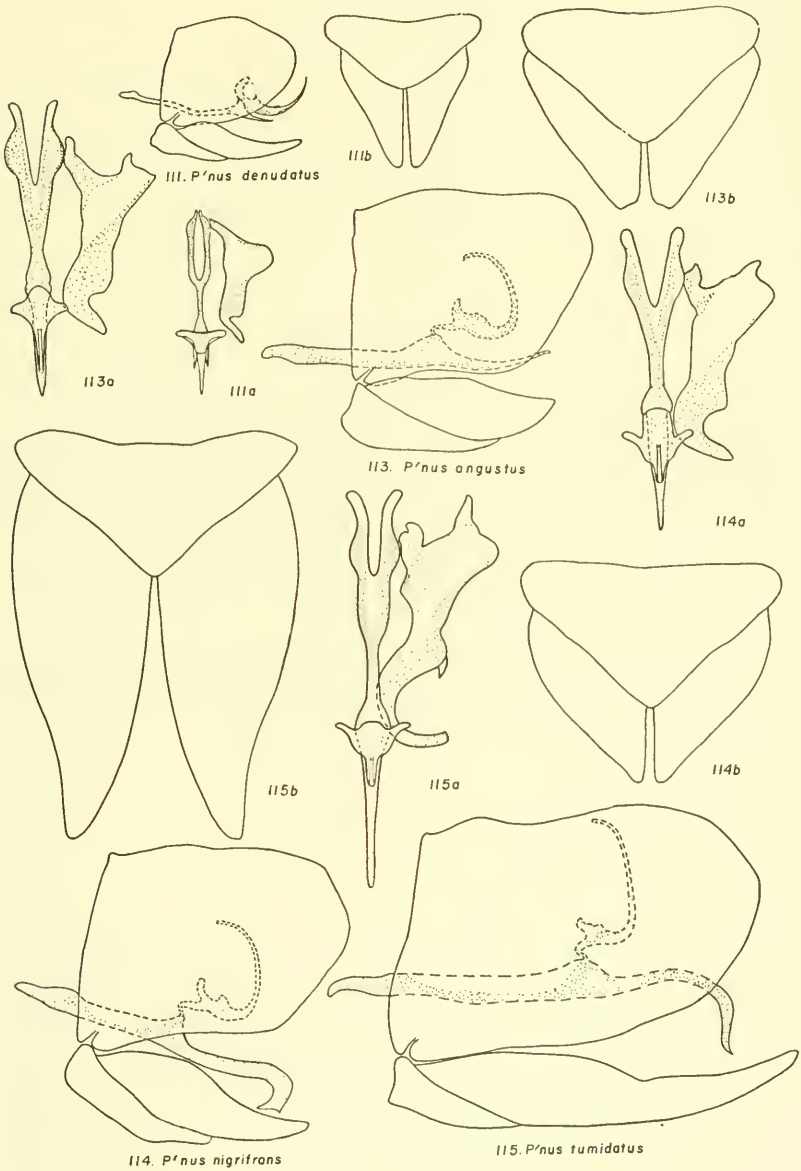

111. P'nus denudatus
111b
113b
113a
111a
113. P'nus angustus
114a
115b
115a
114b
114. P'nus nigrifrons
115. P'nus tumidatus

PLATE 73

FIG. 116. Lateral view of male genital capsule of *Phlepsanus vanduzei* (Ball); 116a, dorsal view of aedeagus, connective, and right style; 116b, ventral view of valve and plates.

FIG. 117. Lateral view of male genital capsule of *Aplanus albidus* (Ball); 117a, dorsal view of aedeagus, connective, and right style; 117b, ventral view of valve and plates.

FIG. 118. Lateral view of male genital capsule of *Aplanus pauperculus* (Ball); 118a, dorsal view of aedeagus, connective, and right style; 118b, ventral view of valve and plates.

FIG. 119. Lateral view of male genital capsule of *Remadosus fumidus* (Osborn); 119a, dorsal view of aedeagus, connective, and right style; 119b, ventral view of valve and plates.

PLATE 73

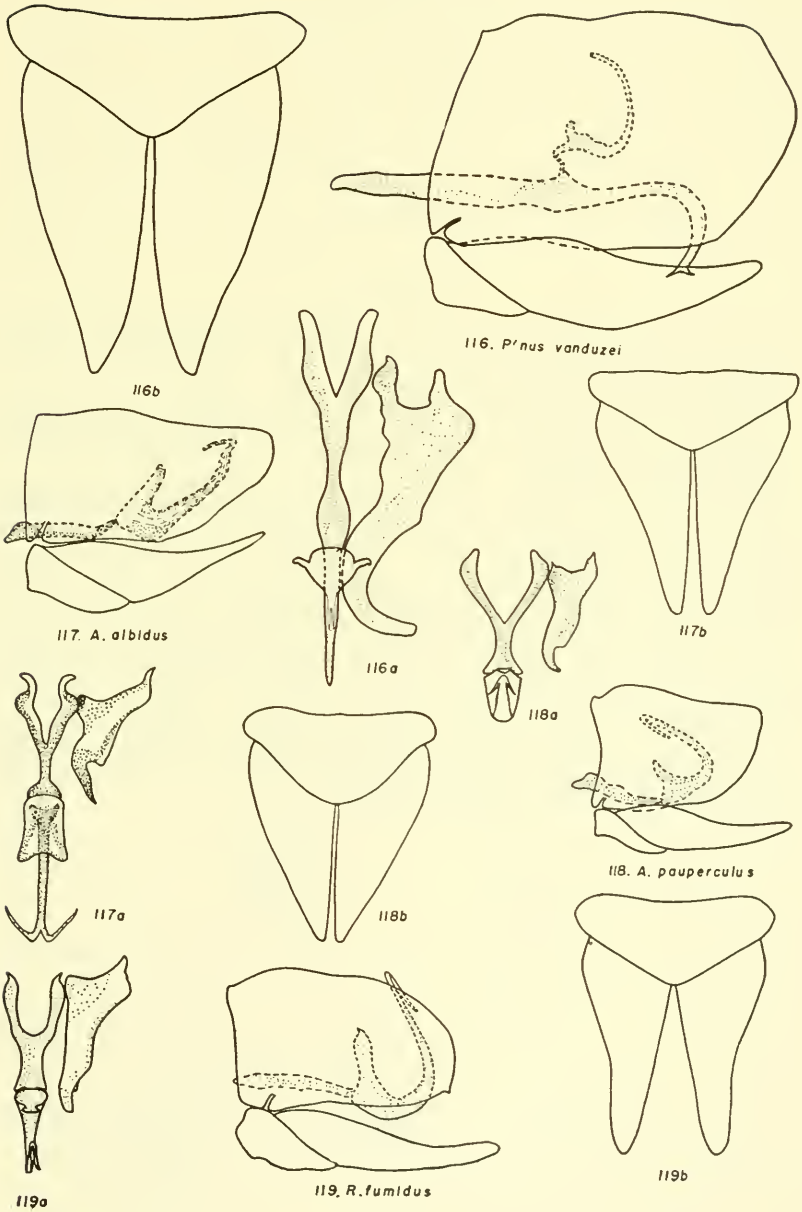

116b
116. P'nus vanduzei
117. A. albidus
116a
117b
118a
117a
118b
118. A. pauperculus
119a
119. R. fumidus
119b

PLATE 74

FIG. 120. Lateral view of male genital capsule of *Remadosus magnus* (Osborn and Ball); 120a, dorsal view of aedeagus, connective, and right style; 120b, ventral view of valve and plates.

FIG. 121. Lateral view of male genital capsule of *Remadosus piceus* (Osborn); 121a, dorsal view of aedeagus, connective, and right style; 121b, ventral view of valve and plates.

FIG. 122. Lateral view of male genital capsule of *Dorydiella floridana* Baker; 122a, dorsal view of aedeagus, connective, and right style; 122b, ventral view of valve and plates.

FIG. 123. Lateral view of male genital capsule of *Dorydiella kansana* Beamer; 123a, dorsal view of aedeagus, connective, and right style; 123b, ventral view of valve and plates.

FIG. 124. Lateral view of male genital capsule of *Orientus ishidae* (Matsumura); 124a, dorsal view of aedeagus, connective, and right style; 124b, ventral view of valve and plates.

FIG. 125. Lateral view of male genital capsule of *Tropicanus costomaculatus* (Van Duzee); 125a, dorsal view of aedeagus, connective, and right style; 125b, ventral view of valve and plates.

PLATE 74

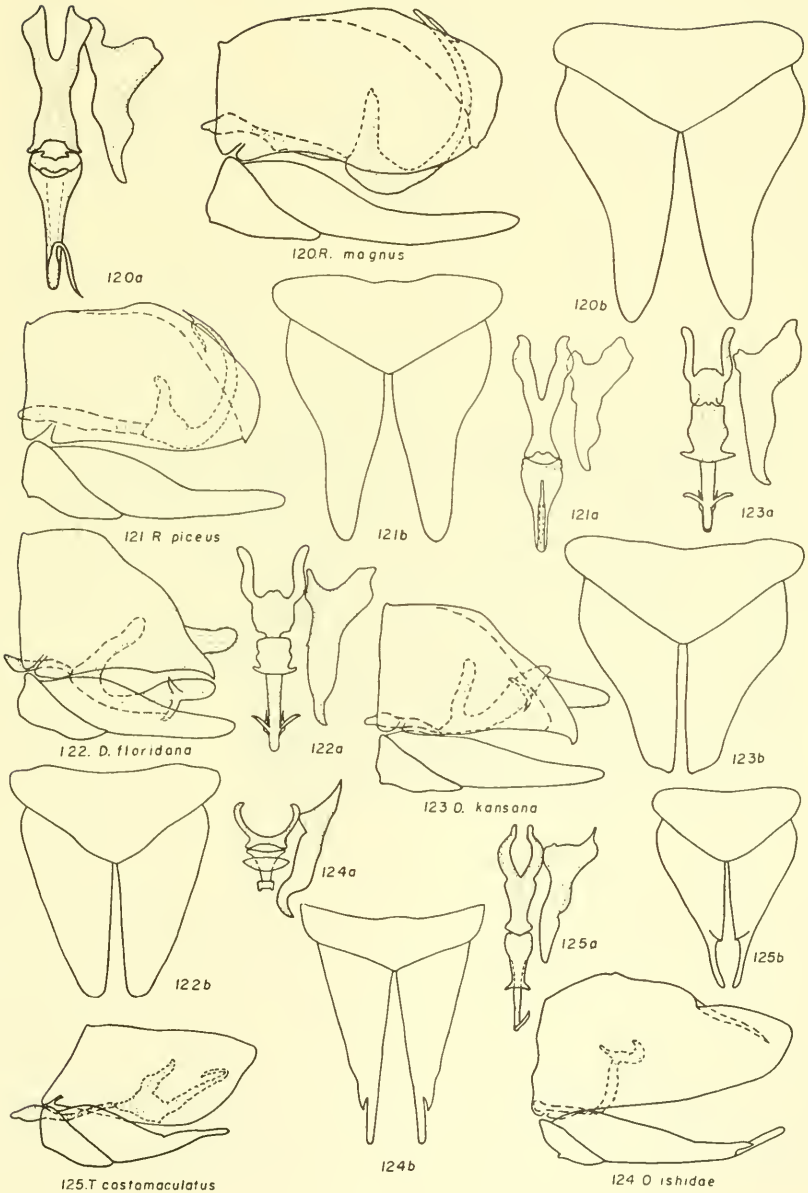

120a
120R. magnus
120b
121 R piceus
121b
121a
123a
122. D. floridana
122a
123 D. kansana
123b
122b
124a
125a
125b
125.T castamaculatus
124b
124 D ishidae

PLATE 75

Ventral view of female seventh sternum

FIG. 2c. *Texananus* (*Texananus*) *spatulatus* Van Duzee
FIG. 3c. *Texananus* (*Texananus*) *sabinus* (Sanders and DeLong)
FIG. 4c. *Texananus* (*Texananus*) *personatus* (Baker)
FIG. 5c. *Texananus* (*Texananus*) *rufusculus* (Osborn and Lathrop)
FIG. 6c. *Texananus* (*Texananus*) *vermiculatus* DeLong
FIG. 7c. *Texananus* (*Texananus*) *oregonus* (Ball)
FIG. 8c. *Texananus* (*Texananus*) *angus* DeLong
FIG. 9c. *Texananus* (*Texananus*) *superbus* (Van Duzee)
FIG. 10c. *Texananus* (*Texananus*) *lathropi* Osborn and Lathrop
FIG. 11c. *Texananus* (*Texananus*) *extensus* n. sp.
FIG. 12c. *Texananus* (*Texananus*) *mexicanus* (Ball)
FIG. 13c. *Texananus* (*Texananus*) *latipex* DeLong
FIG. 14c. *Texananus* (*Texananus*) *areolatus* (Baker)
FIG. 15c. *Texananus* (*Texananus*) *extremus* (Ball)

PLATE 75

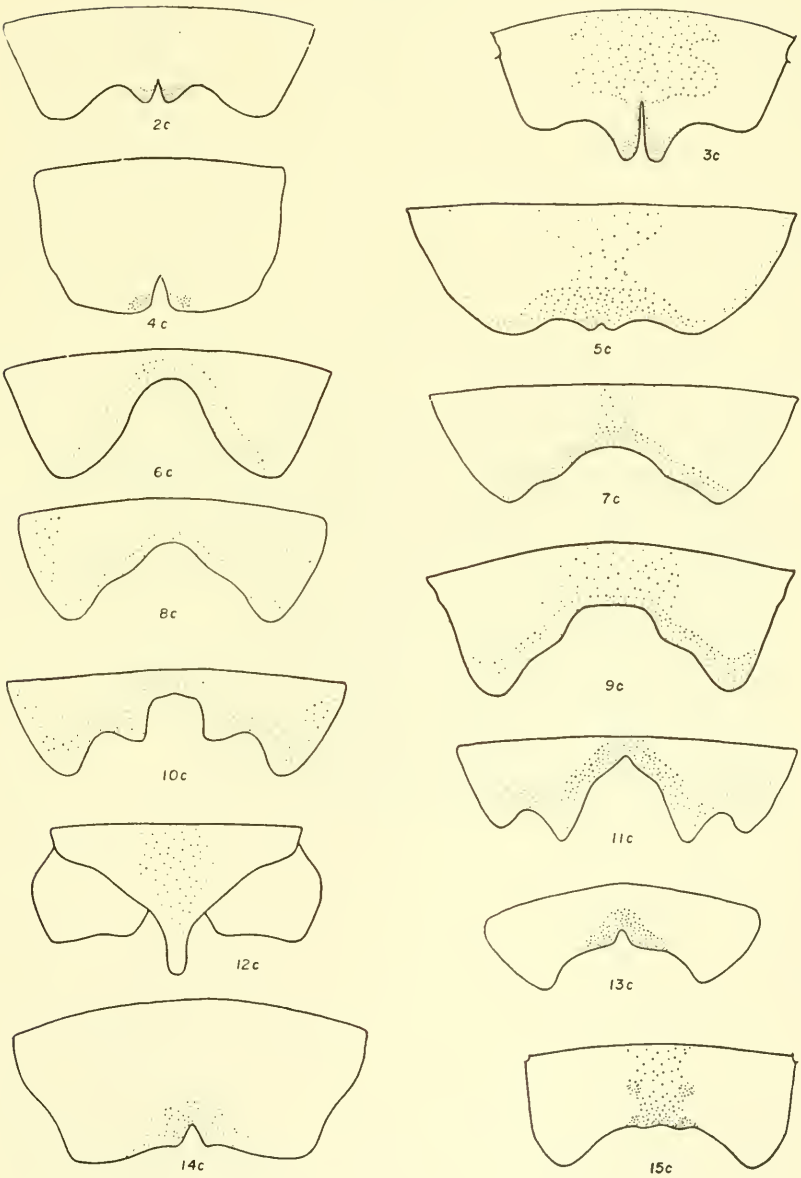


PLATE 76

Ventral view of female seventh sternum

FIG. 16c. *Texananus* (*Texananus*) *fumosus* n. sp.
FIG. 17c. *Texananus* (*Texananus*) *dolus* DeLong
FIG. 19c. *Texananus* (*Texananus*) *decorus* (Osborn and Ball)
FIG. 20c. *Texananus* (*Texananus*) *deversus* DeLong and Hershberger
FIG. 21c. *Texananus* (*Texananus*) *pergradus* DeLong
FIG. 22c. *Texananus* (*Texananus*) *ovatus* (Van Duzee)
FIG. 23c. *Texananus* (*Texananus*) *ovatus* subsp. *distinctus* (Lathrop)
FIG. 24c. *Texananus* (*Texananus*) *sextus* n. sp.
FIG. 25c. *Texananus* (*Texananus*) *gladius* DeLong
FIG. 26c. *Texananus* (*Texananus*) *denticulus* (Osborn and Lathrop)
FIG. 27c. *Texananus* (*Texananus*) *graphicus* (Ball)
FIG. 29c. *Texananus* (*Texananus*) *marmor* (Sanders and DeLong)
FIG. 30c. *Texananus* (*Texananus*) *cumulatus* (Ball)
FIG. 31c. *Texananus* (*Texananus*) *arctostaphylae* (Ball)
FIG. 32c. *Texananus* (*Texananus*) *monticolus* DeLong
FIG. 35c. *Texananus* (*Texananus*) *validus* n. sp.

PLATE 76

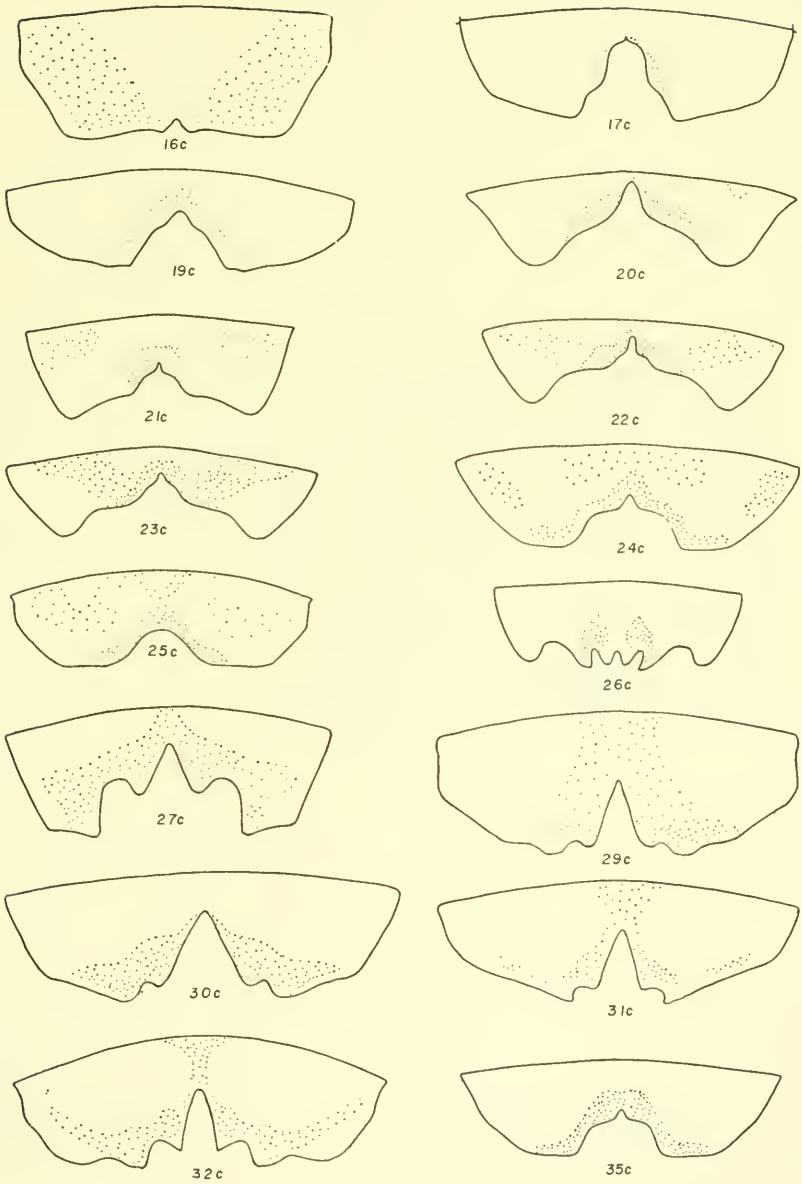


PLATE 77

Ventral view of female seventh sternum

FIG. 36c. *Texananus* (*Excultanus*) *dorothyi* DeLong
FIG. 37c. *Texananus* (*Excultanus*) *excultus* (Uhler)
FIG. 38c. *Texananus* (*Excultanus*) *incurvatus* Osborn and Lathrop
FIG. 39c. *Texananus* (*Excultanus*) *neomexicanus* (Baker)
FIG. 40c. *Texananus* (*Iowanus*) *lyratus* (DeLong and Hershberger)
FIG. 41c. *Texananus* (*Iowanus*) *majestus* (Osborn and Ball)
FIG. 42c. *Texananus* (*Iowanus*) *dicentrus* DeLong
FIG. 43c. *Texananus* (*Iowanus*) *caducus* DeLong
FIG. 44c. *Texananus* (*Iowanus*) *bullatus* DeLong
FIG. 45c. *Texananus* (*Iowanus*) *longipennis* n. sp.
FIG. 46c. *Paraphlepsius nudus* (Ball)
FIG. 47c. *Paraphlepsius cinereus* (Van Duzee)
FIG. 48c. *Paraphlepsius truncatus* (Van Duzee)
FIG. 49c. *Paraphlepsius texanus* (Baker)

PLATE 77

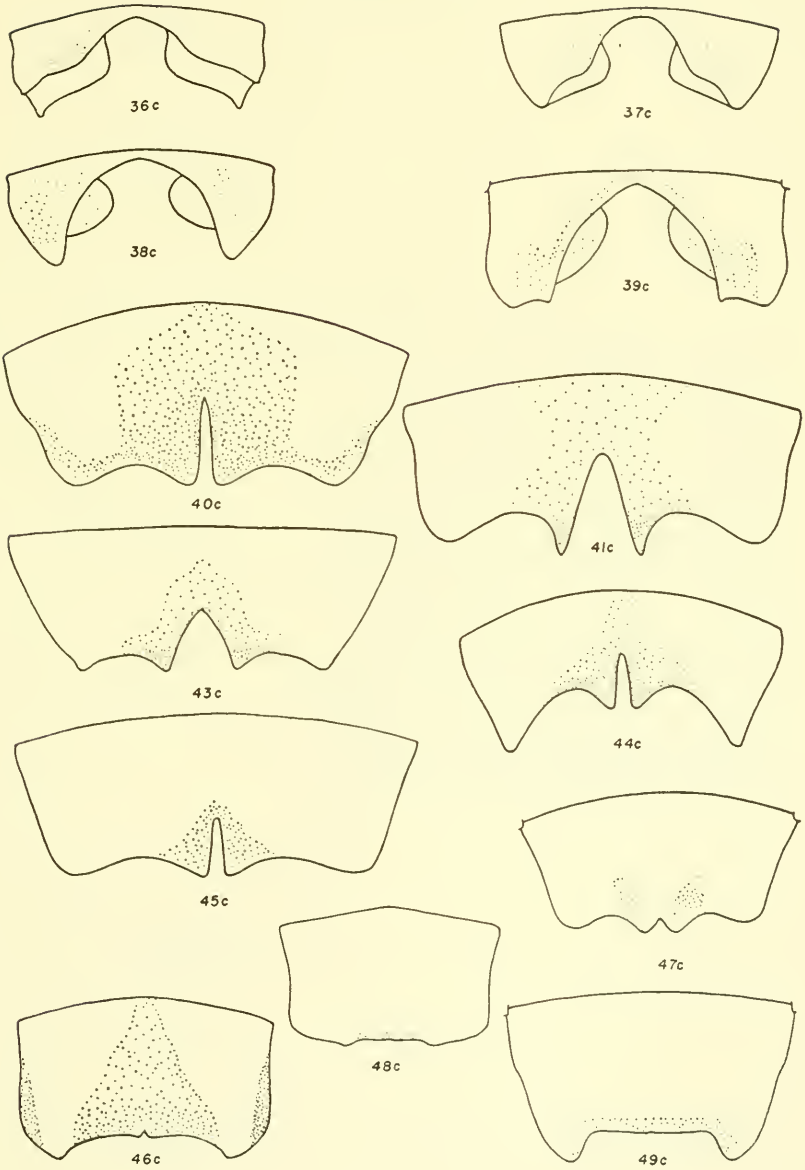


PLATE 78

Ventral view of female seventh sternum

FIG. 51c. *Paraphlepsius planus* Sanders and DeLong
FIG. 52c. *Paraphlepsius cornutus* n. sp.
FIG. 53c. *Paraphlepsius floridanus* (Ball)
FIG. 54c. *Paraphlepsius lascivius* (Ball)
FIG. 55c. *Paraphlepsius bipartitus* (DeLong)
FIG. 56c. *Paraphlepsius tubus* (Ball)
FIG. 57c. *Paraphlepsius lobatus* (Osborn)
FIG. 58c. *Paraphlepsius torridus* (Lathrop)
FIG. 59c. *Paraphlepsius umbrosus* (Sanders and DeLong)
FIG. 60c. *Paraphlepsius collitus* (Ball)
FIG. 61c. *Paraphlepsius attractus* (Ball)
FIG. 62c. *Paraphlepsius solidaginis* (Walker)
FIG. 63c. *Paraphlepsius humidus* (Van Duzee)
FIG. 64c. *Paraphlepsius carolinus* (Lathrop)
FIG. 65c. *Paraphlepsius optatus* (Crumb)
FIG. 66c. *Paraphlepsius pusillus* (Baker)
FIG. 67c. *Paraphlepsius occidentalis* (Baker)

PLATE 78

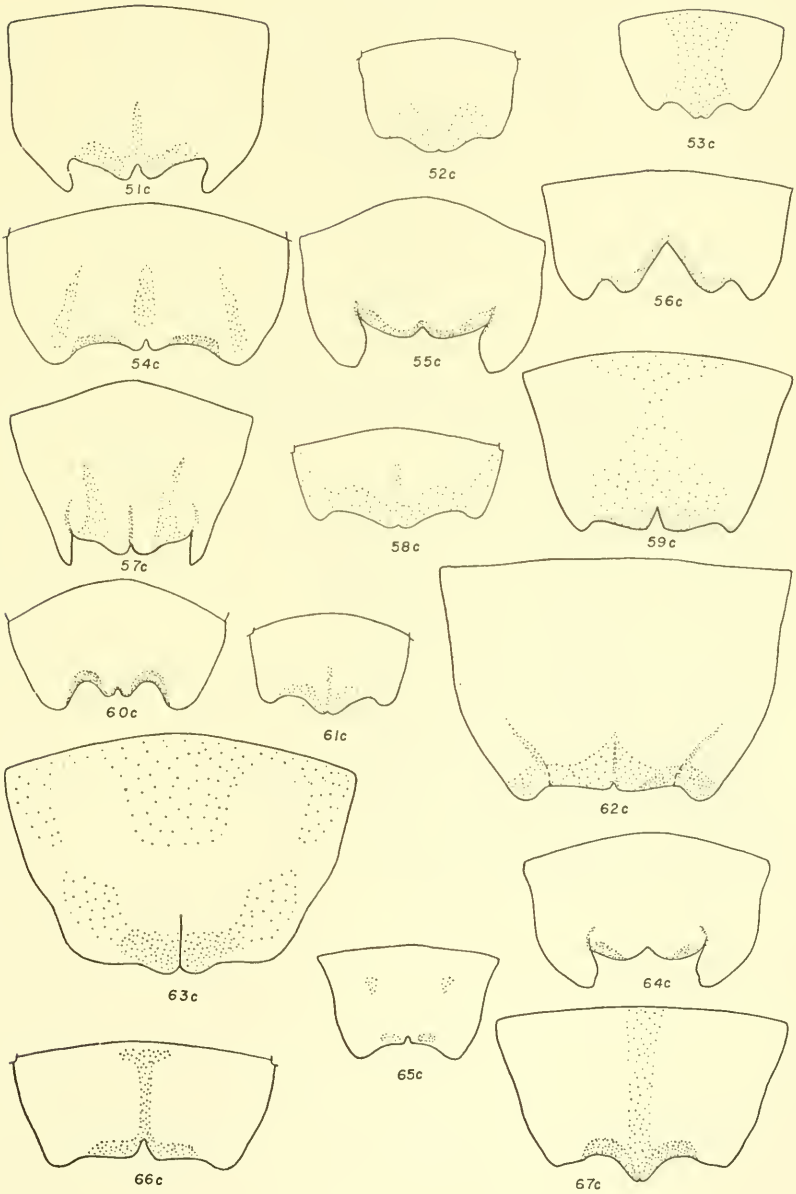

51c
52c
53c
54c
55c
56c
57c
58c
59c
60c
61c
62c
63c
64c
65c
66c
67c

PLATE 79

Ventral view of female seventh sternum

FIG. 68c. *Paraphlepsius eburneolus* Osborn and Lathrop
FIG. 69c. *Paraphlepsius apertinus* (Osborn and Lathrop)
FIG. 70c. *Paraphlepsius excavatus* n. sp.
FIG. 71c. *Paraphlepsius acutus* n. sp.
FIG. 72c. *Paraphlepsius apertus* (Van Duzee)
FIG. 73c. *Paraphlepsius irroratus* (Say)
FIG. 74c. *Paraphlepsius altus* (Osborn and Ball)
FIG. 75c. *Paraphlepsius fulvidorsum* (Fitch)
FIG. 76c. *Paraphlepsius tennessa* (DeLong)
FIG. 77c. *Paraphlepsius macullelus* (Osborn)
FIG. 78c. *Paraphlepsius certus* (DeLong)
FIG. 79c. *Paraphlepsius dentatus* (Baker)
FIG. 80c. *Paraphlepsius hemicolor* (Sanders and DeLong)
FIG. 81c. *Paraphlepsius tigrinus* (Ball)
FIG. 82c. *Paraphlepsius rossi* (DeLong)
FIG. 83c. *Paraphlepsius palustris* (Sanders and DeLong)
FIG. 84c. *Paraphlepsius lippulus* (Ball)
FIG. 85c. *Paraphlepsius strobi* (Fitch)
FIG. 86c. *Paraphlepsius spinosus* n. sp.

PLATE 79

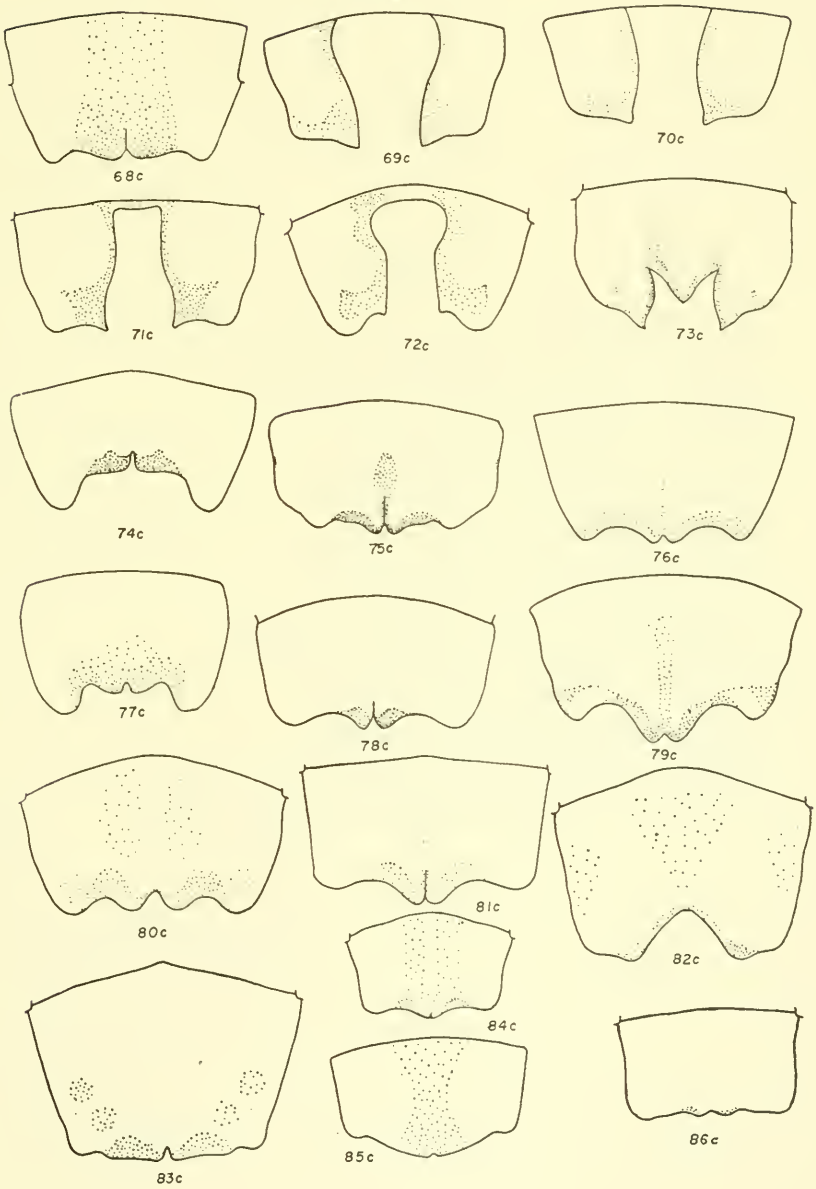

68c
69c
70c
71c
72c
73c
74c
75c
76c
77c
78c
79c
80c
81c
82c
83c
84c
85c
86c

PLATE 80

Ventral view of female seventh sternum

FIG. 88c. *Paraphlepsius avicephalus* n. sp.
FIG. 89c. *Paraphlepsius punctiscriptus* (Van Duzee)
FIG. 90c. *Paraphlepsius slossonae* (Ball)
FIG. 91c. *Paraphlepsius tullahoma* (DeLong)
FIG. 92c. *Paraphlepsius obvius* (Oman)
FIG. 93c. *Paraphlepsius emarginatus* n. sp.
FIG. 94c. *Paraphlepsius maculosus* (Osborn)
FIG. 95c. *Paraphlepsius pallidus* (Van Duzee)
FIG. 96c. *Paraphlepsius divergens* (Oman)
FIG. 97c. *Paraphlepsius operculatus* (Ball)
FIG. 98c. *Paraphlepsius mimus* (Baker)
FIG. 99c. *Paraphlepsius bifidus* (Sanders and DeLong)
FIG. 100c. *Paraphlepsius turpiculus* (Ball)
FIG. 101c. *Paraphlepsius abruptus* (DeLong)
FIG. 102c. *Paraphlepsius continuus* (DeLong)
FIG. 103c. *Paraphlepsius siclus* (DeLong)
FIG. 104c. *Paraphlepsius fuscipennis* (Van Duzee)
FIG. 105c. *Paraphlepsius fuscipennis* var. *seminolus* (DeLong)

PLATE 80

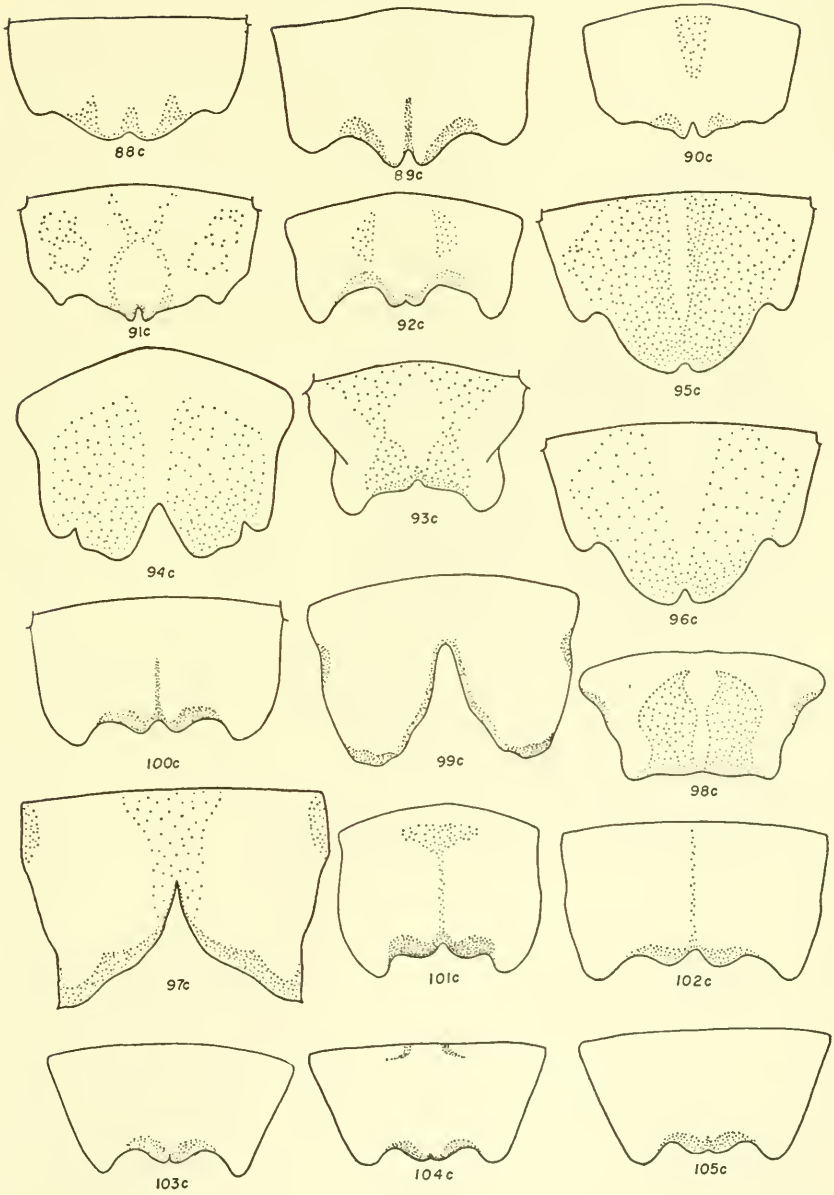
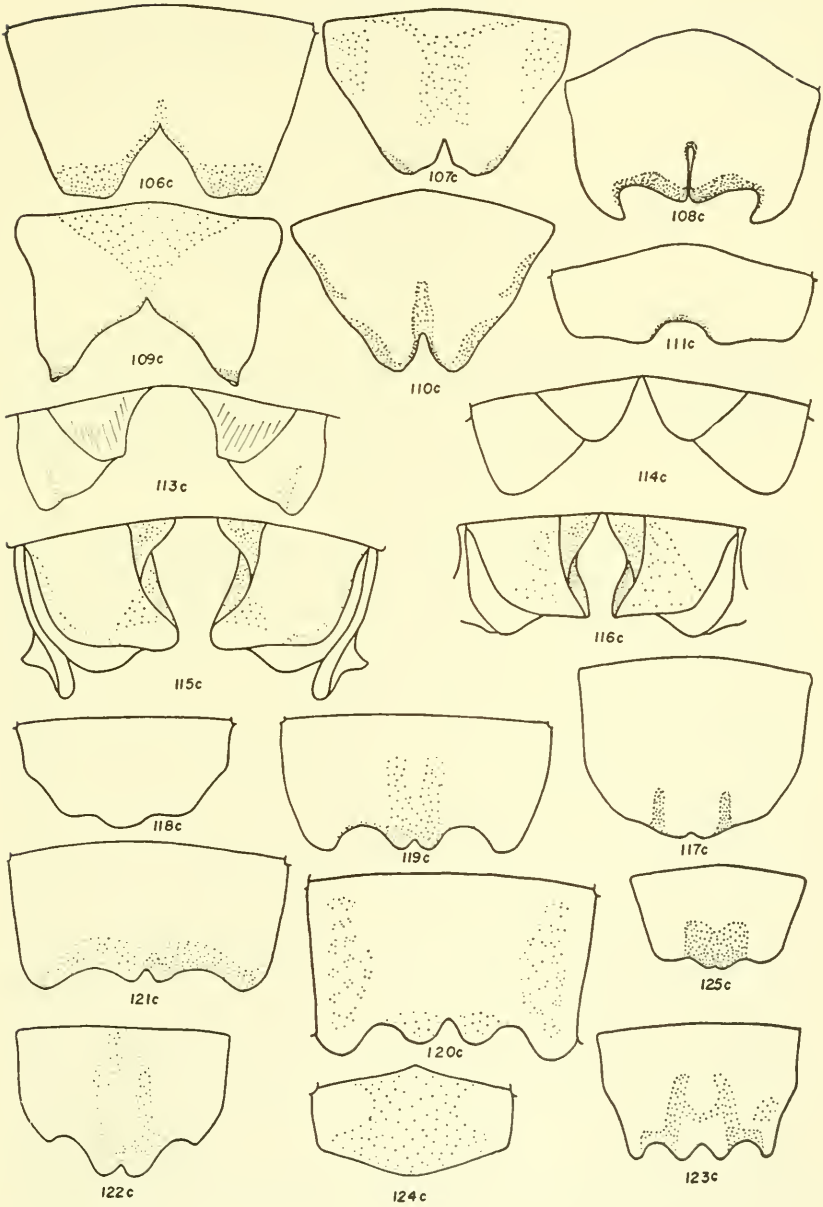

88c
89c
90c
91c
92c
95c
94c
93c
96c
100c
99c
98c
97c
101c
102c
103c
104c
105c

PLATE 81

Ventral view of female seventh sternum

FIG. 106c. *Paraphlepsius rileyi* (Baker)
FIG. 107c. *Paraphlepsius incisus* (Van Duzee)
FIG. 108c. *Paraphlepsius brunneus* (DeLong)
FIG. 109c. *Paraphlepsius latifrons* (Van Duzee)
FIG. 110c. *Paraphlepsius particolor* (Sanders and DeLong)
FIG. 111c. *Paraphlepsius denudatus* (Ball)
FIG. 113c. *Paraphlepsius angustus* n. sp.
FIG. 114c. *Paraphlepsius nigrifrons* (Ball)
FIG. 115c. *Paraphlepsius tumidatus* n. sp.
FIG. 116c. *Paraphlepsius vanduzei* (Ball)
FIG. 117c. *Aplanus albidus* (Ball)
FIG. 118c. *Aplanus pauperculus* (Ball)
FIG. 119c. *Remadosus fumidus* (Osborn)
FIG. 120c. *Remadosus magnus* (Osborn and Ball)
FIG. 121c. *Remadosus piceus* (Osborn)
FIG. 122c. *Dorydiella floridana* Baker
FIG. 123c. *Dorydiella kansana* Beamer
FIG. 124c. *Orientus ishidae* (Matsumura)
FIG. 125c. *Tropicanus costomaculatus* (Van Duzee)

PLATE 81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Preliminary Study of the Taxonomy and Ecology of Kansas Lichens

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ABSTRACT: The total number of species and varieties of lichens known for the state of Kansas is 163. Previously reported species and varieties totaled 33. Certain definite interrelationships between the State's geology, topography, climate, and higher plant associations have been noticed. These ecological factors have been dealt with in an explanation of lichen distribution.

INTRODUCTION

A survey of Kansas botanical literature previous to 1950 shows a decided lack of information concerning an interesting and widely distributed group of plants, the lichens. Realizing this fact, collections of lichens were made in conjunction with other botanical work by Mr. R. L. McGregor during the years 1948 and 1949. These collections were the incentive for the present systematic study of the lichens of Kansas. The extent of Kansas' lichen-flora was not realized at the beginning and it was thought that a reasonably complete check list could be completed in a short time. Within a period of three months about 90 species of lichens were determined. This was approximately three times the number previously known for the State. This suggested that there were many more species present. With this increase in known species and varieties, another problem became evident. It could be seen from collection-data that each of the main higher plant associations in the State contained a distinct lichen-component differing markedly from the lichen-component of other plant associations. Knowledge of the lichen-members of such plant associations is lacking as is knowledge of the relationships of lichens to their environment in these associations.

Field work was conducted during the spring, summer, and fall of 1950. During this time 102 of the 105 counties were surveyed.

Special attention was paid to geological formations as they are charted on geological maps of the State. Great assistance was derived from the State Geological Map by R. C. Moore and K. K. Landes (1937). Available information concerning the vegetation and plant associations of the region was also used.

Nomenclature, in most cases, follows that of Fink (1935). The greatest deviation from this nomenclature is found in the genus *Cladonia.* All collections of Kansas Cladoniae were sent to Dr. A. W. Evans of Yale University for his examination, consequently all determinations of this genus are his.

The purpose of this paper is not only to supply some information concerning the species present in Kansas but also to indicate how these species are related to their environments. It is realized that this work will prove to be far from complete. It is hoped that it will serve as a basis for further taxonomic work on the lichenflora of Kansas as well as supply added information concerning lichens of the different plant associations.

ACKNOWLEDGMENTS

Appreciation is expressed to several persons for assistance in the identification of various groups of lichens. All collections of Cladoniae were identified by Dr. A. W. Evans of the Osborn Botanical Laboratory, Yale University. The material of the genus *Parmelia* was identified or verified by Dr. A. W. C. T. Herre of the University of Washington. Dr. C. W. Dodge of the Missouri Botanical Gardens identified many specimens of the material collected by Mr. R. L. McGregor, or R. L. McGregor and P. H. Humfeld in the summer and fall of 1949. Much of the material is represented by duplicate collections in the herbaria of these authorities.

It was through the inspiration and assistance of Mr. R. L. McGregor that this project was concluded. His knowledge of the area studied and the higher plants found in Kansas proved to be of untold aid. His collections of Kansas lichens were the incentive for the commencement of this project.

Grateful acknowledgment is made to the following members of the University of Kansas for consultation and assistance whenever called upon: Dr. W. H. Horr for assistance in the collecting of material; Dr. A. J. Mix for knowledge concerning the fungi encountered, as well as for editing and commenting upon the manuscript; and Dr. R. H. Thompson for information concerning the algae encountered as well as for correcting and commenting upon the manuscript.

HISTORY

The first published record of Kansas lichens was that of Tuckerman (1882). In this work three species of lichens are listed as occurring in Kansas. No general treatment of the lichen-flora was attempted. Two years later Willey (1884) published a short paper in which 11 species and varieties of lichens were listed. The specimens upon which this paper was based had been sent to Willey by Prof. Cragin and his students of the Washburn Laboratory of Natural History, Topeka, Kansas. Cragin (1885) published a note on Kansas lichens in which he listed the records of both Tuckerman and Willey as well as adding two of his own. Willey (1886) reported 14 species and varieties for Kansas. Tuckerman (1888) mentions 7 more species and varieties of lichens as occurring in the state. None of the specimens listed by either Willey or Cragin have been located in any of the herbaria of the State or elsewhere.

The literature from 1888 to 1935 lacks any mention of Kansas lichens except for the citation by H. Magnuson (1929) of *Acarospora subcontigua* H. Mag. *var. invadens* H. Mag. in his *Monograph of the Genus Acarospora*. In 1935, *The Lichen Flora of the United States* was published by Fink. Eleven species and varieties not previously recorded for Kansas are listed. This brought the total published records concerning Kansas lichens to thirty-three species and varieties. The present paper brings the list to 163 species, varieties and forms. It is estimated that this figure is less than one third of the lichens which will be found to occur in Kansas when a complete survey is made.

GEOLOGY AND TOPOGRAPHY OF KANSAS

Kansas rock formations are composed, for the most part, of sandstones, limestones and shales. It is only in the western reaches of the State that large tertiary deposits of sand, gravel, and partially solidified sediments are found. The Doniphan County soils along the Missouri River and the sand dune areas of Harvey, Barton and Rice counties compose the largest wind formed deposits in Kansas.

The oldest rock outcrops that are found in Kansas are the Mississippian shales and limestones in extreme southeastern Kansas. This Mississippian outcropping will be referred to later when plant distribution is considered.

Pennsylvanian rock formations are found overlaying the Mississippian and compose the rocks of eastern Kansas. The northwestern border of Pennsylvanian outcrops almost coincides with the western border of Chautauqua County, and extends northeast through Lyon and Shawnee counties leaving the State about in the north-central part of Brown County. The Pennsylvanian rock formations are composed largely of alternate layers of limestone, shale, and sandstone with coal deposits in some areas. Due to the gentle slope of these formations to the westward, large east-facing escarpments are formed by the hard hilltop caps of well-solidified limestone. These form the predominant topographical features of the eastern portion of the State.

Located to the west of the Pennsylvanian deposits are large formations of Permian limestone and shales as well as some salt formations. The western border of these outcrops extends through the center of Sedgwick County northward through McPherson, Dickinson and Clay counties leaving Kansas at the north-central part of Washington County. Outcrops of these formations are also found in Barber, Comanche and Clark counties. These outcrops are composed of large deposits of reddish sandstone and gypsum. The gypsum deposits exhibit a general inhibiting effect on plant growth and this area is as botanically sterile as any single general area in the State.

To the west of the Permian outcrops the Cretaceous outcrops appear. The Dakota sandstone, reddish brown in color, composes the great area of central western Kansas called the Smoky Hill Uplands. To the west of these large sandstone outcrops are deposits of limestone, shale and chalk. These formations make up the Blue Hill Uplands.

The formations now covering the uplands of western Kansas are largely Tertiary sands, clays, and gravels, some of which are partially solidified into caliches. Quaternary alluvial deposits dominate the lowlands of these areas, the largest of which is found along the Arkansas River.

The topography of Kansas is not noted for its roughness. The surface of the state slopes in general from an elevation of 4,000 feet in the northwest corner, eastward and southward to an elevation of slightly less than 800 feet in Cherokee County. The main topographical features of the State are formed by the action of streams and rivers as well as wind cutting these gradually sloping surfaces into locally elevated areas. Drainage of the northern one

half of the state is controlled by the Kansas River and its tributaries. This system is the largest river system in Kansas.

The drainage of south central Kansas is dominated by the Arkansas River which flows east from Colorado through Kansas and is forced southward into Oklahoma by the Pennsylvanian outcrops known as the Flint Hills. The drainage of the extreme southwestern parts of the state is controlled by the Cimarron and Medicine Rivers, each of which has cut deeply into the land over which they flow forming large bluffs, buttes, and valleys from the soft rock formations of their drainage area. It is the Medicine River drainage system which is responsible for the surfacing of the Permian red beds in Barber, Comanche, and Clark counties.

KANSAS CLIMATE [1]

The climate of Kansas is marked by high diversity. Weather changes are sharp and conditions are generally variable because the State lies across the path of alternate masses of warm moist air moving north from the Gulf of Mexico and cold dry air masses moving south from polar regions. In spite of this, Kansas has more clear days than any state east or north of it. In addition it has lower average humidity than any state east of the Rocky Mountain Continental Divide. The movement of air north and south has a marked effect on wind velocities. Winds in the eastern part of Kansas do not differ greatly from those of Missouri, Iowa, Ohio and Pennsylvania. The winds of southwestern Kansas, however, nearly approach those of the Texas panhandle and western Oklahoma which is the windiest inland region of the Nation outside of the Great Lake region and some local mountainous areas.

From a survey of meteorological statistics, Kansas can be divided into three general weather areas. Each of these areas composes approximately one third of the State. The eastern region is marked by the highest rainfall of the State; 35.27 inches yearly. Humidity is also highest in this eastern region. Growing seasons are the longest here and weather changes less violent. The smallest variations between high daytime temperatures are found here. The yearly variations between high and low temperatures are also lower in this region.

The central one third of the State is characterized by drier air, more sunshine, and less rainfall than the eastern climatic region. The average yearly rainfall is 26.45 inches. Winds are stronger in

1. Information on climate obtained from Flora, S. D., Climate of Kansas. Rpt., Kans. State Bd. Agric., vol. 66, 1948, pp. 1-320. 1948.

this area but not as strong as in the area to the west. In general it can be said that growing conditions are not as good in the central climatic region as they are in the region to the east of it.

The western one third of the State is marked by violent weather reactions. Winds are the strongest in this area. The number of sunny days is greater. The relative humidities are surpassed in lowness only by the southwestern part of the United States. All in all, it is the poorest region in the State for the survival of plants.

It can be seen from the above discussion that Kansas weather contributes to great variation in ecological conditions. Its effect on plant distribution will be seen later.

THE FLORA OF KANSAS: GENERAL

As indicated in the introduction, lichen-distribution in Kansas appears to be closely associated with the distribution and nature of the major plant associations. To understand the lichen-distribution and the ecology in this area it is necessary to have an understanding of the major plant associations of the State and of their distribution. For this purpose it seems best to discuss Kansas flora beginning in the southeastern portion of the State and working northward and westward describing the flora as it occurs. A detailed account will not be attempted since this paper deals primarily with lichens.

In the southeast corner of Cherokee County a discrete area consisting of about six square miles is evident. The flora of this area is Ozarkian in nature and is reported to support a larger number of species than any other single area of equal size in the State. The region has previously been called the Ozark Plateau hence the flora of this area will be referred to as the flora of the Ozark Plateau.

The characteristic flora of the hilltops and slopes of this area is composed of oaks and hickories, the important species are *Quercus alba, Q. velutina, Q. macrocarpa, Q. stellata,* and *Q. shumardii* as well as *Carya glabra, C. cordiformis,* and *C. tomentosa.* Occasional specimens of *Ulmus americana, U. alata, Cornus florida, Amelanchier canadensis, Viburnum rufidulum, Juglans nigra, Benzoin aestivale* as well as others may be found. It is forests of this type which will prove to be of importance later when lichen distribution is discussed.

The flora of the valleys of this area is characterized generally by *Platanus occidentalis, Ulmus americana, Celtis occidentalis, Betula nigra,* and *Salix spp.*

Space does not permit the listing of undershrubs and herbaceous plants peculiar to this area. Reference to *Plants New to Kansas*

Herbaria by W. H. Horr and R. L. McGregor (1946, 1947, 1948, 1949, 1950) will give an indication of new plants found only in this area. It would appear from these reports and from other papers dealing with Kansas flora that many plants find their northwestern limit in this small area of six square miles.

To the west and north of the Ozark Plateau a much larger and highly important part of Kansas vegetation is found. This region is composed of deciduous forests and tall-grass prairies. The western border of this region is formed by a line drawn from the Kansas-Oklahoma state line just west of Arkansas City in Cowley County northeastward to Sedan in Chautauqua County, northward through the western parts of Anderson and Franklin counties to the Kansas-Nebraska state line. The area is designated as Area No. 2 (Map).

The eastern tier of counties and the northern and southern parts of this area are characterized by having oak-hickory forests covering the Pennsylvanian limestone outcrops. Along the streams are found mixed forests quite unlike the hillside flora. Often the uplands are covered by bluestem prairies. These prairies are undoubtedly of less extent now than they have been in the past because of the plowing of land. As one progresses to the western confines of this general area the region in which oak-hickory forests predominate becomes smaller until on the western fringe it is confined only to the moist hillsides, often only on the south sides of the stream valleys. The point of disappearance of these forests is about 130 miles west of the Kansas-Missouri line in extreme southern Kansas. In central Kansas this distance decreases to about 70 miles.

Throughout this area the characteristic trees on the limestone hilltops and slopes are: *Quercus macrocarpa, Q. muhlenbergii, Q. velutina, Carya glabra, C. ovata,* and *C. cordiformis.* On the sandy hilltops and slopes one finds the characteristic trees to be *Quercus marilandica, Q. stellata,* and *Q. velutina.* Along the streams the mixed forest is found in both sandstone and limestone situations. The characteristic trees are: *Ulmus rubra, U. americana, Platanus occidentalis, Celtis occidentalis, Populus deltoides, Acer saccharinum,* and *Salix spp.* The undergrowth of the forests varies considerably.

To the west of the oak-hickory forests is an area characterized by tall grasses. The region is designated as Area No. 3 (Map) and is commonly referred to as the Flint Hills. The dominant grass of the area is *Andropogon gerardi.* In locations of reduced

moisture, *Andropogen scoparius* becomes dominant while in more moist situations *Andropogon gerardi* and *Spartina pectinata* are generally found.

The forests of the tall-grass region, generally confined to the streams and river valleys, are extensions of the mixed forests of the rivers and streams in the area to the east. The characteristic trees encountered are *Ulmus americana, U. rubra, Celtis occidentalis, Populus deltoides, Salix spp., Quercus macrocarpa, Q. muhlenbergii, Acer negundo, A. saccharinum,* and *Fraxinus pennsylvanica.* These trees exhibit their usual habitat-preferences and therefore one finds characteristic *Populus-Salix, Acer-Ulmus,* and *Quercus* groupings.

As stated earlier the Flint Hills are composed primarily of Permian limestones. Thickets of young elm, hackberry, ash, and box elder are found covering the escarpments of limestone in Area No. 2. This type of growth is not widespread.

To the west of the tall-grass association, a mid-grass association is located which is designated as Area No. 4 (Map). This area is primarily composed of a mixture of the flora of the tall-grass region and of the short-grass region of the western reaches of the State. Tall grasses often are characteristic of the moist sandstone areas while short grasses, mostly buffalo grass, are found on the drier uplands. *Andropogon gerardi* and *A. scoparius* may be evident to some extent on the uplands but they do not form a significant part of the flora on these uplands. In the sandy areas, primarily along the Arkansas River, *Andropogon hallii, A. gerardi, Calamovilfa gigantea,* and *Panicum virgatum* predominate. Short grass species found in the drier regions of the area are *Buchloe dactyloides* and *Bouteloua curtipendula.*

The most western plant association of the State is the short-grass association indicated as Area No. 5 (Map). This area is partially xerophytic and short grasses are the only characteristic plants able to survive on the uplands. The principal short grasses of this region are *Buchloe dactyloides, Bouteloua curtipendula, B. gracilis* and *B. hirsuta.* Occasionally colonies of *Andropogon gerardi* may be found in the more moist areas and *Andropogon scoparius* in the slightly drier habitats.

No forests are found in this region. Trees that are able to survive are confined to the large streams and rivers. Occasional trees such as *Populus deltoides, P. sargentii, Salix spp., Ulmus americana, Acer negundo,* and *Fraxinus pennsylvanica* may be found in the northern parts of this general region. In the south *Tamarix gallica*

composes an important member of the river-valley flora. *Celtis rugulosa* and *C. reticulata* may also be found. The only other woody plant of any significance in the area is *Prunus spp.* which occur in scattered thickets.

LICHEN DISTRIBUTION AND ECOLOGY

The preceding information concerning geology and topography, climate, and plant associations will be used in the following discussion. The interrelationships exhibited between these major ecological factors will become evident. The object now is to indicate the relationship of lichen distribution to these major ecological factors, and in so doing, discuss the various lichen associations which were noted. The logical method of approach to such a discussion seems again to be that of commencing in the southeastern region of the state and describing the situations as they would be encountered in moving northwestward across the state.

The habitats suitable for lichens in the Ozark Plateau region Area No. 1 (Map) are of three distinct types. Because of the dense forest, an important lichen growth is found on the trees, both living and dead. An equally important habitat for lichens is found on the large Mississippian limestone outcrops of the region. The most noticeable component of the lichen flora of this area, however, is found on the yellow and orange clay soils found composing the forested hillsides. Lichens characterized as growing on soil in these areas are:

Amphiloma lanuginosum (Hoffm.) Nyl.
Baeomyces placophyllus Ach.
Cladonia capitata (Michx.) Spreng. *f. imbricatula* (Nyl.) Evans
Cladonia cryptochlorophaea Asahina
Cladonia Grayi Merrill *f. cyathiformis* Sandst.
Cladonia strepsilis (Ach.) Vainio
Parmelia cetrata Ach.

Peltigeria cania (L.) Willd. and *Cladonia furcata* (Huds.) Schrad. *var. racemosa* (Hoffm.) Floerke may also be found on these clay hillside soils but they do not appear as characteristic components of the lichen flora. Their occurrence is sporadic and confined to local isolated areas.

It is interesting to note that, as with higher plants, there are lichens that occur in this area which are not found elsewhere in the State. The species that have been found in this area only are: *Cladonia furcata* (Huds.) Schrad. *var. racemosa* (Hoffm.) Floerke

f. squamulifera Sandst., *Cladonia polycarpia* Merrill, *Cetraria juniperina* (L.) Ach., and *Bilimbia sphaeroides* (Dicks.) Koerb.

Lichens which are found regularly on the oaks, hickories and other trees either living or dead in the upland forests are: *Physcia asteroideae* (Clem.) Nyl., *Physcia stellaris* (L.) Nyl., *Physcia tribacia* (Ach.) Nyl., and *Teloschistes spp. Amphiloma lanuginosum* (Hoffm.) Nyl. occurs regularly on bark in areas which are moist. Often it is confined to the base of tree trunks in very shaded situations. Species of the genus *Graphis,* so common on hickories in the eastern part of the State, are also found. *Cladonia bacillaris* (Del.) Nyl. and *Cladonia capitata* (Michx.) Spreng. often may be found growing on partially decomposed logs and similar material.

Typical lichens on the limestone outcrops of the Ozark Plateau are *Lecanora versicolor* (Pers.) Ach., *Buellia spuria* (Schaer.) Anzi, *Physcia teretuscula* (Ach.) Lynge and *Baeomyces placophyllus* Ach. The two last named are found typically on small pockets of decomposed limestone and humus on or around the rock outcrops. They are often found growing associated with mosses. *Lecanora versicolor* (Pers.) Ach. is found only on rocks which are exposed to the full rays of the sun. It will be seen later that this lichen is not only able to survive in exposed areas in this location but also is able to exist in the semiarid regions of western Kansas. It is interesting to note that two lichens, *Lecanora rugosa* (Pers.) Nyl. and *Protoblastenia rupestris* (Scop.) Steiner are found only on limestone outcrops of these areas and nowhere else in the State.

Area No. 2 (Map) has the largest and most diverse lichen flora of any area of the State. This is partly because of the variations found in the type of rock outcroppings and partly because of the diverse nature of the vegetation of the area. It was stated earlier that the outcrops of this region are Pennsylvanian limestone, sandstone, and shale. The influences of these rocks on lichen distribution are so great that each of the two former rock types must be discussed separately. Likewise the lichen-flora of these locations differs so much from the typical prairie lichen-flora of the region that these also must be dealt with separately as must the soil forms of the forested areas. Another subdivision necessitated by distinct lichen-flora groupings is the lichen-flora found on the numerous trees in the area.

The lichen-flora of the limestone outcrops occupies the larger portion of Area No. 2. The number of species in these areas is

not as great, however, as those found in the sandstone regions. Species which are characteristic of moist shaded limestone outcrops are:

Amphiloma lanuginosum (Hoffm.) Nyl.
Anaptychia aquila (Ach.) Mass.
Dermatocarpon aquaticum (Weis.) Zahlbr.
Dermatocarpon miniatum (L.) Mann
Dermatocarpon miniatum (L.) Mann *var. complicatum* (Light.) T. Fries
Peltigera canina (L.) Willd.
Physcia adglutinata (Floerke) Nyl.

Species which one may or may not find on the crest of these outcrops in the sun are:

Acarospora immersa Fink
Biatorella simplex (Dav.) Branth and Rostr.
Biatorella simplex (Dav.) Branth and Rostr. *var. prunosa* (Ach.) Fink
Candelariella vitellina (Ehrh.) Müll.
Lecanora badia (Hoffm.) Ach.
Lecanora versicolor (Pers.) Ach.
Lecidea lithophila Ach.
Psora russellii (Tuck.) Schneid.

The discreteness of these two lichen associations is very evident. Never is there any mixture of the two groups. This is partially explained by the fact that many of the species in the first group are found at the western most extent of their range. The converse is true of the second list in that the most eastern extension of the more xerophytic species is in this region.

Other species of lichens which are found growing on limestone are:

Caloplaca aurantica (Lightf.) T. Fries
Lecanora cinera (L.) Röhlong
Lecanora hageni Ach.
Lecanora murialis (Schreb.) Rabh.
Lecidea cyanea (Ach.) Röhling
Staurothele clopima (Wahl.) T. Fries
Verrucaria virens Nyl.

These lichens are represented only by a limited number of collections hence they can not be included as typical lichens of limestone areas.

Found both in limestone areas, such as has just been dealt with,

and in sandstone areas the following characteristic lichens are found growing on the bark of trees:

Amphiloma lanuginosum (Hoffm.) Nyl.
Graphis scripta (L.) Ach.
Parmelia rudecta Ach.
Pertusaria multipuncta (Turn.) Lam. and DC.
Physcia asteroidea (Clem.) Nyl.
Physcia obscuria (Ehrh.) Hampe
Physcia tribacia (Ach.) Nyl.
Teloschistes candelarius (L.) Fink
Teloschistes polycarpus (Ehrh.) Tuck.
Teloschistes candelarius (L.) Fink *var. pygmaeus* (Bory) Fink

In addition to those just listed, the following lichens are also sparingly present:

Arthronia cytisi Mass.
Arthronia patellulata Nyl.
Arthronia polymorpha Ach.
Candelaria fibrosa (E. Fries) Müll.
Pertusaria lecanina Tuck.
Physcia adglutinata (Floerke) Nyl.
Physcia crispa (Pers.) Nyl.
Physcia setosa (Ach.) Nyl.
Pyxine sorediata (Ach.) E. Fries
Rinodinia sophodes (Ach.) Mass.

A definite host-preference is exhibited by some lichens. The species of *Physcia* which are found on tree bark are found more commonly on the bark of *Ulmus americana* and *U. rubra* and to some extent on the bark of shrubs. A preference is exhibited for the bark of dead or dying trees. Species of *Teloschistes* are similar to those of *Physcia* in their preferences and thalli of *Physcia* and *Teloschistes* may be found growing in very close relationship to each other. *Arthronia spp.* and *Graphis scripta* (L.) Ach. exhibit a preferance for the trees with smooth bark such as *Carya glabra.* Only rarely are either of these genera found on other trees. Species of *Parmelia,* on the contrary, show a decided preference for the rough bark trees such as the oaks. *Amphiloma lanuginosum* (Hoffm.) Nyl. is extremely cosmopolitan and may be expected to grow on almost any tree where there is enough moisture and shade to allow it to survive.

Pennsylvanian sandstone occurs in Area No. 2 (Map) as local outcrops. In some cases the indications of sandstone areas may be

manifest only in the form of sandy soil. Local sandstone outcrops occur in Douglas, Leavenworth, Woodson, Wilson, Chautauqua, Jefferson, Greenwood, Montgomery, Franklin and Elk Counties. In all of these areas *Quercus* or *Quercus-Carya* associations are characteristic. Usually these forests are so disposed that areas of sandstone are exposed to the sun during the greater part of the day. Such locations are hot and dry during the summer and fall months. Lichens which are typical of such situations are:

Biatorella simplex (Dav.) Branth and Rostr.
Candelariella vitellina (Ehrh.) Müll.
Lecanora versicolor (Pers.) Ach.
Parmelia cetrata Ach.
Parmelia molliuscula Ach.
Parmelia conspersa (Ehrh.) Ach.
Uroceolaria scurposa (Schreb.) Ach.

Other species found in this type of habitat but which are not present in large enough quantity to be considered characteristic are:

Acarospora subcontigua H. Magn.
Acarospora subcontigua H. Magn. *var. invadens* H. Magn.
Biatorella clavatus (Lam. and DC.) T. Fries
Parmelia borreri Turner
Psora russellii (Tuck.) Schneid.
Rinodinia ocellata (Hoffm.) Arn.

All of the lichens found growing on exposed sandstone may be found growing in close association to each other except *Biatorella clavatus* (Lam. and DC.) T. Fries which has always been found growing by itself.

Species of lichens which are found to occur in the more shaded and moist sectors of sandstone outcrops are:

Amphiloma lanuginosum (Hoffm.) Nyl.
Cladonia capitata (Michx.) Spreng. *f. imbricatula* (Nyl.) Evans
Cladonia cryptochlorophaea Asahina
Parmelia centrifuga (L.) Ach.
Parmelia crinita Ach.
Peltigera canina (L.) Willd.

Species found less regularly in shady sandstone areas are:

Cladonia pleurota (Floerke) Schaer.
Cladonia subcariosa Nyl. *f. evoluta* Vainio
Parmelia borreri Turner
Physcia teretiuscula (Ach.) Lynge

Usnea barbata (L.) Wigg.
Usnea subfusca Stirtion
Usnea variolosa Mot.

Lichens found growing on soil in Area No. 2 have added greatly to the known lichen flora of the State. These lichens can not be discussed in one group, however, since there are two separate associations evident. The smaller of the two associations is the lichen-flora of the grasslands. The soils of the grasslands are generally calcareous in nature and are drier than the soils of the forested areas. The only lichens typical of this situation are *Solorinaria dexpreauxii* (Mont.) Fink and *Dermatocarpon rufescens* (Ach.) T. Fries. It will be seen later that *Dermatocarpon rufescens* (Ach.) T. Fries is a very common lichen found in the short grass prairies of western Kansas.

The sandy soils found in many local areas of Wilson, Woodson, Chautauqua, Greenwood, Douglas, Jefferson and Leavenworth Counties present a very interesting flora. Such soils are moist and in most cases shaded. They support a forest of the *Quercus* or *Quercus-Carya* type. Lichens characteristic of such areas are:

Bacomyces rufus (Huds.) Rebent.
Cladonia capitata (Michx.) Spreng.
Cladonia capitata (Michx.) Spreng. *f. imbricatula* (Nyl.) Evans
Cladonia cryptochlorophaea Asahina
Cladonia furcata (Huds.) Schrad.
Cladonia furcata (Huds.) Schrad. *var. racemosa* (Hoffm.) Floerke
Cladonia pleurota (Floerke) Schaer.
Cladonia subcariosa Nyl.
Peltigera canina (L.) Willd.

The similarity between these species and species found typically on sandstone should be noted. Lichens found occasionally or rarely on shady, sandy soil in the moist forested areas are:

Cladonia capitata (Michx.) Spreng. *f. abbreviata* (Vainio) Evans
Cladonia capitata (Michx.) Spreng. *f. pallida* Robbins
Cladonia consista (Ach.) Robbins *f. simplex* Robbins
Cladonia gracilis (L.) Willd. *var. dilata* (Hoffm.) vainio *f. squamulosa* (Schaer.) Sandst.
Cladonia grayi Merrill
Cladonia grayi Merrill *f. carpophora* Evans
Cladonia grayi Merrill *f. cyathiformis* Sandst.

Cladonia grayi Merrill *f. squamulosa* Sandst.
Cladonia piedmontensis Merrill
Cladonia piedmontensis Merrill *f. squamulosa* Robbins
Cladonia robbinsii Evans
Cladonia robbinsii Evans *f. squamulosa* Evans
Cladonia strepsilis (Ach.) Vainio
Cladonia strepsilis (Ach.) Vainio *f. corralloideae* (Ach.) Vainio
Cladonia subtenuis (Des Abbayes) Evans
Dermatocarpon cinereum (Pers.) T. Fries
Cladonia subcariosa Nyl.
Parmelia centrifuga (L.) Ach.
Parmelia cetrata Ach.
Physcia teretiuscula (Ach.) Lynge

The *Cladonia-Peltigera* association which has just been described as occurring on shaded, moist, sandy soil can, in the author's opinion, be designated as an indicator association in determining a definite set of environmental conditions.

The tall-grass association, designated as Area No. 3 (Map) is an area of relative unimportance as far as lichens are concerned. As explained earlier, the soils of this area are calcareous and the outcrops small and sporadic in occurrence. The value of discussing this area lies in the fact that it appears to be the meeting point of the lichen associations of eastern Kansas and the lichen associations of western Kansas. Lichens which are found in this region occur sporadically on limestone, concrete, fenceposts, and trees in the stream and river valleys. Lichens which are found occasionally on limestone and concrete are:

**Acarospora immersa* Fink
Acarospora peltasticta Zahlbr.
**Acarospora subcontigua* H. Magn. *var. invadens* H. Magn.
Biatorella simplex (Dav.) Branth and Rostr.
**Lecidea lithophila* Ach.
Lecanora dispersa (Pers.) Röhl.
Lecanora versicolor (Pers.) Ach.
Psora russellii (Tuck.) Schneid.
Rinodinia ocellata (Hoffm.) Arn.

Lichens which can be found growing on calcareous soils of this area are **Cladonia capitata* (Michx.) Spreng. *f. pallida* Robbins and *Dermatocarpon rufescens* (Ach.) T. Fries. The former is confined to the clay soils of the sparsely forested slopes of stream

* Lichens found only in Area No. 3 and no other place in the State. They are, however, represented by small collections and cannot be considered to be common in the area.

and river valleys. *Dermatocarpon rufescens* (Ach.) T. Fries is typical of the prairie soils as found in Area No. 2 to the east.

Lichens which may be found growing on tree bark in the river valleys are:

Amphiloma lanuginosum (Hoffm.) Nyl.
Physcia stellaris (L.) Nyl.
Physcia obscura (Ehrh.) Hampe
Teloschistes candelarius (L.) Fink
Teloschistes polycarpus (Ehrh.) Tuck.

Lichens which are also reported from tree bark in this area and are more characteristic of the oak-hickory forests of the east are:

Caloplaca microphylina (Tuck.) Hasse
Candelaria fibrosa (E. Fries) Müll.
Pertusaria multipuncta (Turn.) Nyl.
Physcia adglutinata (Floerke) Nyl.
Physcia asteroides (Clem.) Nyl.
Teloschistes euploeus (Tuck.) Zahlbr.

Before discussing the lichen flora of Area No. 4 (Map) it seems necessary to mention several geologically and floristically distinct divisions within the confines of the general area. As was mentioned in the discussion of geology and topography, Area No. 4 is a flat area composed of Permian sandstone and limestone. The typical flora of this area is composed of both short and tall grasses. The limestone outcrops are confined to the eastern portion of the area. The flora of these areas is composed of extensions of the flora of the tall-grass area of the east by way of the stream valleys which dissect the limestone outcrops. Lichens of these areas will not be discussed since they are also typical of the more easternly tall grass region.

The sand-hill area of Reno, Harvey, and Stafford counties as well as of Edwards County is another peculiar region which, because of its size, cannot be overlooked. Sands in this region are partly wind deposited and partly deposited by the Arkansas River. At times these sands are in motion forming dunes and drifts. During moist seasons grasses hold the sand and blowing is greatly reduced. Small cottonwood forests may be found by the streams and ponds in the area. The lichen flora of the sand areas is confined to these trees. *Physcia stellaris* (L.) Nyl. and *Teloschistes candelarius* (L.) Fink may be found commonly. Other lichens may be found occasionally but only the above two species can be considered typical.

Another distinct area is found in Barber and Comanche counties. This is a discrete isolated outcropping composed of reddish Permian sandstone and dolomite. The Medicine River has cut buttes, canyons and large gullies through the soft rocks. Due to large gypsum deposits in this area the lichen-flora is almost nonexistent. Other plants such as liverworts, mosses, and ferns occur only rarely. Species of *Physcia* and *Teloschistes* may exist on the trees of the stream valleys. *Dermatocarpon rufescens* (Ach.) T. Fries also may be found in the upland pastures and prairies but its occurrence is not as common here as farther to the west.

Dakota sandstone outcrops are found in several local regions of Area No. 4. These outcrops are not large and sometimes the only indication one is able to get of sandstone rock below the surface soil is the presence of sandy soil. Where the Dakota sandstone is evident as large rocks and boulders, the lichen flora is very discrete and different from the surrounding areas. Outcrops of this type are found in Saline, Ottawa, Clay, Cloud, Washington, Lincoln and Kiowa counties. The outcrops around Kanapolis Reservoir in Ellsworth County and the outcrops around Belvidere in Kiowa County are the largest outcrops of Dakota sandstone in the area. Lichens typical of these sandstone areas are:

Acarospora subcontigua H. Magn.
Biatorella simplex (Dav.) Branth and Rostr.
Lecanora versicolor (Pers.) Ach.
Parmelia conspersa (Ehrh.) Ach.
Psora russellii (Tuck.) Schneid.
Urceolaria actinostoma Pers.
Urceolaria scurposa (Schreb.) Ach.

Lichens also found occurring in such locations are:

Acarospora arenosa Herre
Acarospora flava (Bell.) Trev.
Acarospora glaucocarpa (Ach.) Koerb. *var. verrucosa* (Anzi.) Magn.
Buellia insidians (Nyl.) Zahlbr.
Buellia tusconensis Zahlbr.
Caloplaca auranticaca (Lightf.) T. Fries
Candelariella vitellina (Ehrh.) Müll.
Lecanora dispersa (Pers.) Röhl.
Lecanora deplanans Nyl.
Lecanora polytropa (Ehrh.) Rabh.
Parmelia borreri Turner

Peltigera canina (L.) Willd.
Parmelia molliuscula Ach.
Psora petri (Tuck.) Fink
Rinodinia biatorina Koerb.

Peltigera canina (L.) Willd. and *Parmelia borreri* Turner exist in this area only in very moist and shaded locations. Their occurrence in this area is definitely not typical. They both are typical of the oak-hickory forests of the eastern part of Kansas. *Parmelia borreri* Turner is usually found growing on oak bark in the east but has been collected here from sandstone.

Dermatocarpon rufescens (Ach.) T. Fries is the only lichen which may be found regularly growing on soil throughout the mixed grass prairies. *Psora icterica* (Mont.) Müll. may be found on occasions but it does not occur with regularity. *Cladonia pleurota* (Floerke) Schaer. and *Cladonia cryptochlorophaea* Asahina can be found in very moist and highly shaded locations growing on soil. These lichens may be considered as atypical forms since they are more characteristic of the soils of the oak-hickory forest. Their occurrence in this region is highly sporadic.

Lichens which are found growing on the trees of the river valleys in Area No. 4 are:

Physcia adglutinata (Floerke) Nyl.
Physcia stellaris (L.) Nyl.
Teloschistes candelarius (L.) Fink
Teloschistes candelarius (L.) Fink *var. pygmaeus* (Bory) Fink
Teloschistes chrysophthalmus (L.) Beltr.
Teloschistes euplocus (Tuck.) Zahlbr.

Since trees in some parts of this major area are not numerous, these lichens may not be found everywhere.

The lichen flora of Area No. 5 (Map) is confined to the partially solidified Tertiary sedimentary rocks and soil of the area. Outcrops of caliche support the largest number of lichens found here. Lichens which can always be found on these outcrops are:

Acarospora peltasticta Zahlbr.
Acarospora subcontigua H. Mgan.
Biatorella simplex (Dav.) Branth and Rostr.
Lecanora versicolor (Pers.) Ach.
Psora russellii (Tuck.) Schneid.

Lichens which also may be found occasionally are:

Acarospora saxicola Fink

Biatorella simplex (Dav.) Branth and Rostr. *var. prunosa* (Ach.) Fink
Candelariella crenulata (Wahl.) Zahlbr.
Lecanora atriseda (E. Fries) Nyl.
Lecanora polytropa (Ehrh.) Rabh.
Rinodinia radiata Tuck.
Solorina saccata (L.) Ach.
Uroceolaria actinostoma Pers.

Staurothele diffractella (Nyl.) Tuck. occurs, as far as known, only on chalk deposits in Trego and Logan counties.

Dermatocarpon rufescens (Ach.) T. Fries is the only common lichen found growing on soil in the western areas of the State. This lichen grows in association with blue-green algae such as *Nostoc* and together they form a very tenacious soil-holding crust. Often small pedestals of soil can be found with the lichen growing on top of it.

Trees in this area are not common. Because of this, lichens growing on bark are not found frequently. Often many trees may be found that do not support any lichens. This may partially be because the hot dry winds which frequently occur in the area do not allow the foliose lichens to exist. Lichens which may be found in this area on tree bark are:

Lecanora cupressi Tuck.
Lecanora varia (Hoffm.) Ach.
Physcia adglutinata (Floerke) Nyl.
Physcia stellaris (L.) Nyl.
Physcia tribacia (Ach.) Nyl.
Teloschistes candelarius (L.) Fink

ANNOTATED LIST OF KANSAS LICHENS

1. Acarospora arenosa Herre
   Growing on sandstone. *Clark Co.*, O. S. Fearing 391.*
2. Acarospora citrina (Tayl.) Zahlbr.
   Kansas: Cragin (1885).
3. Acarospora flava (Bell.) Trev.
   Growing on sandstone exposed to the direct rays of the sun. *Ellsworth Co.*, O. S. Fearing 285.
4. Acarospora fuscata (Schrad.) Arn.
   Kansas: Cragin (1885).
5. Acarospora glaucocarpa (Ach.) Koerb. var. verrucosa (Anzi) Magn.
   Kansas: Cragin (1885), Fink (1935). Sandstone: *Ellsworth Co.*, O. S. Fearing 284.

* Numbers after collectors' names refer to field numbers of specimens now in the author's private collection.

6. Acarospora immersa Fink
   Growing on limestone: *Pottawatomie Co.*, O. S. Fearing 298.
7. Acarospora peltasticta Zahlbr.
   Growing on sandstone: *Kiowa Co.*, O. S. Fearing 397; *Stanton Co.*, R. L. McGregor 422, 4556, 4557, 4552. Growing on concrete: *Morris Co.*, O. S. Fearing 250. Growing on volcanic rock: *Meade Co.*, O. S. Fearing 355. Growing on chalk: *Scott Co.*, O. S. Fearing 523. Growing on caliche and conglomerate rocks: *Scott Co.*, O. S. Fearing 441, 542, 442, 541.
8. Acarospora saxicola Fink
   Growing on sandstone and caliche: *Decatur Co.*, O. S. Fearing 422.
9. Acarospora subcontigua H. Magn.
   Generally is found growing on the most exposed parts of rock outcrops. In the western parts of the state it covers the sandstone rocks. Growing on sandstone: *Barton Co.*, R. L. McGregor 4633; *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 104; *Ellsworth Co.*, O. S. Fearing 267, 274(a), 261, 506; *Greenwood Co.*, O. S. Fearing 150(b), 155; *Kiowa Co.*, O. S. Fearing 400, R. L. McGregor 3244. Growing on limestone: *Riley Co.*, O. S. Fearing 290. Growing on conglomerate and caliche: *Scott Co.*, O. S. Fearing 440(b), 488.
10. Acarospora subcontigua H. Magn. var. invadens H. Magn.
    Growing on rocks in pasture: *Riley Co.*, F. C. Gates. *Ellis Co.*, (3,000 ft.) Lindahl. (A monograph of the genus Acarospora by A. H. Magnusson.)
11. Amphiloma lanuginosum (Hoffm.) Nyl.
    This lichen can be found growing in shaded areas on soil, sandstone, or the bark of numerous trees. It is usually found in very shaded places. Growing on sandstone: *Douglas Co.*, O. S. Fearing 31, 25; *Ellsworth Co.*, O. S. Fearing 262, 264; *Leavenworth Co.*, O. S. Fearing 68; *Kiowa Co.*, O. S. Fearing 399. Growing on moist soil: *Doniphan Co.*, O. S. Fearing 323; *Cherokee Co.*, M. Brewster (Spring 1950); *Wyandotte Co.*, W. H. Horr (1950). Growing on the bark of *Ailanthus* sp.: *Miami Co.*, O. S. Fearing 676. *Carya glabra* bark: *Douglas Co.*, O. S. Fearing 45; *Leavenworth Co.*, O. S. Fearing 76(b), 63(d). Growing on elm bark; *Atchison Co.*, O. S. Fearing 220. Growing on *Quercus* sp. bark: *Douglas Co.*, O. S. Fearing 47, 32. Growing on sycamore bark: *Leavenworth Co.*, O. S. Fearing 82.
12. Anaptychia aquila (Ach.) Mass.
    Growing on limestone: *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 85; *Linn Co.*, R. L. McGregor and P. H. Humfeld 43.
13. Arthonia cytisi Mass.
    Growing on *Carya glabra* bark: *Douglas Co.*, O. S. Fearing 43(a).
14. Arthonia patellulata Nyl.
    Growing on the bark of *Carya glabra; Douglas Co.*, O. S. Fearing 41.
15. Arthonia polymorpha Ach.
    Growing on hickory bark: *Atchison Co.*, O. S. Fearing 222.
16. Bacidia atrogrisea (Hepp) Koerb.
    Kansas: Fink (1935).

17. Baeomyces placophyllus Ach.
    Growing on limestone and moist soil: *Cherokee Co.*, O. S. Fearing 189, 190.
18. Baeomyces roseus Pers.
    Growing on soil: *Woodson Co.*, O. S. Fearing 574; *Chautauqua Co.*, R. L. McGregor 4392.
19. Baeomyces rufus (Huds.) Rebent.
    Growing on sandy soil in well shaded areas: *Chautauqua Co.*, R. L. McGregor 4195; *Labette Co.*, R. L. McGregor 4441; *Wilson Co.*, O. S. Fearing 582, 589.
20. Biatorella clavus (Lam. and DC.) T. Fries
    Growing on sandy soil: *Chautauqua Co.*, R. L. McGregor 4189.
21. Biatorella simplex (Dav.) Branth and Rostr.
    Growing on rocks in every part of the State. Growing on sandstone: *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 102, O. S. Fearing 615; *Ellsworth Co.*, O. S. Fearing 514; *Hodgeman Co.*, R. L. McGregor 4622(a); *Leavenworth Co.*, O. S. Fearing 90, 91; *Norton Co.*, O. S. Fearing 411, 408; *Saline Co.*, O. S. Fearing 125; *Stanton Co.*, R. L. McGregor 4522; *Wilson Co.*, O. S. Fearing 138. Growing on caliche: *Kingman Co.*, O. S. Fearing 455; *Logan Co.*, O. S. Fearing 429; *Meade Co.*, O. S. Fearing 514. Growing on limestone: *Jefferson Co.*, O. S. Fearing 316. Growing on volcanic ash: *Meade Co.*, O. S. Fearing 367.
22. Biatorella simplex (Dav.) Branth and Rostr. var. pruinosa (Ach.) Fink
    Kansas: Cragin (1885). Growing on caliche: *Logan Co.*, O. S. Fearing 429. Growing on limestone: *Miami Co.*, O. S. Fearing 670.
23. Bilimbia sphaeroides (Dicks.) Koerb.
    Growing on soil: *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 73.
24. Buellia badia (E. Fries) Mass.
    Growing on fence post: *Jefferson Co.*, O. S. Fearing 318.
25. Buellia caloosensis Tuck.
    Growing on oak fence post: *Douglas Co.*, R. L. McGregor 2632.
26. Buellia insidians (Nyl.) Zahlbr.
    Growing on sandstone: *Clark Co.*, O. S. Fearing 393(a).
27. Buellia spuria (Schaer.) Anzi
    Growing on limestone: *Cherokee Co.*, O. S. Fearing 193(a).
28. Buellia stigmaea Tuck.
    Growing on limestone: *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 74, 64.
29. Buellia tucsonensis Zahlbr.
    Growing on sandstone: *Saline Co.*, O. S. Fearing 130.
30. Caloplaca aurantiaca (Lightf.) T. Fries
    Kansas: Tuckerman (1882), Cragin (1885). Growing on limestone: *Jefferson Co.*, G. O. Latham (Fall 1950); *Ellsworth Co.*, O. S. Fearing 281.
31. Caloplaca bracteata (Hoffm.) Jatta
    Growing on limestone rocks: *Wilson Co.*, P. H. Humfeld and R. L. McGregor 119.

32. Caloplaca cerina (Ehrh.) T. Fries
Kansas: Willey (1884).
33. Caloplaca cinnabarina (Ach.) Zahlbr.
Kansas: Willey (1886).
34. Caloplaca ferruginea (Huds.) T. Fries
Kansas: Willey (1884).
35. Caloplaca galactophylla (Tuck.) Zahlbr.
Chase Co., Willey (1886). Kansas: Fink (1935).
36. Caloplaca microphylina (Tuck.) Hasse
Growing on bark of elm tree. *Lyon Co.*, R. L. McGregor 1598, 1596.
37. Caloplaca ulmorum Fink
Kansas: Fink (1935).
38. Candelaria concolor (Dicks.) Arn.
Kansas: Willey (1884).
39. Candelaria concolor (Dicks.) Arn. var. effusa (Tuck.) Merrill and Burnh. Kansas: Willey (1884).
40. Candelaria fibrosa (E. Fries.) Müll.
Growing on *Carya glabra* bark: *Nemaha Co.*, O. S. Fearing 232(b).
41. Candelariella aurella (Hoffm.) Zahlbr.
Kansas: Tuckerman (1882), Cragin (1885).
42. Candelariella crenulata (Wahl.) Zahlbr.
Growing on sandstone: *Logan Co.*, O. S. Fearing 427.
43. Candelariella vitellina (Ehrh.) Müll.
Grows on bark and rocks in shaded humid areas. Growing on cottonwood bark: *Jefferson Co.*, O. S. Fearing 304. Growing on *Quercus sp.* bark: *Jefferson Co.*, O. S. Fearing 631. Growing on limestone: *Miami Co.*, O. S. Fearing 684. Growing on sandstone: *Ellsworth Co.*, O. S. Fearing 266, 508.
44. Cetraria juniperina (L.) Ach.
Growing on bark of trees: *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 52.
45. Cladonia bacillaris (Del.) Nyl.
Growing on dead oak bark and dead organic material of all kinds: *Cherokee Co.*, O. S. Fearing (Summer 1950), R. L. McGregor and P. H. Humfeld 340.
46. Cladonia capitata (Michx.) Spreng.
Growing on sandy soil and decomposed plant material such as stumps, etc.: *Douglas Co.*, R. L. McGregor 2634, O. S. Fearing 35, 54; *Leavenworth Co.*, R. L. McGregor 1427; *Cherokee Co.*, R. L. McGregor 4436.
47. Cladonia capitata (Michx.) Spreng. f. abbreviata (Vainio) Evans
Growing on sandy soil in oak-hickory forests: *Neosho Co.*, O. S. Fearing 168.
48. Cladonia capitata (Michx.) Spreng. f. imbricatula (Nyl.) Evans.
Growing on sandy soil and sandstone in oak-hickory forests: *Chautauqua Co.*, R. L. McGregor 1205; *Cherokee Co.*, R. L. McGregor 4437, R. L. McGregor and P. H. Humfeld 51; *Franklin Co.*, R. L. McGregor and P. H. Humfeld 170, R. L. McGregor 3610; *Jackson*

Co., R. L. McGregor 261; *Jefferson Co.*, R. L. McGregor 1234; *Johnson Co.*, O. S. Fearing 490, 499; *Leavenworth Co.*, O. S. Fearing 74; *Linn Co.*, O. S. Fearing 205(a), 204, R. L. McGregor and P. H. Humfeld 46; *Woodson Co.*, R. L. McGregor 1255.

49. Cladonia capitata (Mich.) Spreng, f. pallida Robbins
Growing on soil, often sandy, in oak forests: *Douglas Co.*, O. S. Fearing 33; *Jefferson Co.*, G. O. Latham 898; *Pottawatomie Co.*, R. L. McGregor and P. H. Humfeld 405.

50. Cladonia conista (Ach.) Robbins f. simplex Robbins
Growing on moist soil in oak-hickory forests: *Jefferson Co.*, O. S. Fearing 644; *Leavenworth Co.*, O. S. Fearing 66(a).

51. Cladonia cryptochlorophaea Asahina
Growing on sandy soil and sandstone in moist shaded parts of oak-hickory forests: *Chanutauqua Co.*, R. L. McGregor and P. H. Humfeld 100, 91, R. L. McGrgeor 440, 4199, 4197, 1202; *Cherokee Co.*, R. L. McGregor and P. H. Humfeld, 71, 50, 49, 65, R. L. McGregor 4438, O. S. Fearing 192; *Douglas Co.*, R. L. McGregor 1171, R. L. McGregor and P. H. Humfeld 27, O. S. Fearing 12, 13, 20, 26; *Ellsworth Co.*, O. S. Fearing 266; *Franklin Co.*, R. L. McGregor 1170; *Jefferson Co.*, R. L. McGregor 4354; *Johnson Co.*, O. S. Fearing 583; *Wilson Co.*, O. S. Fearing 144; *Woodson Co.*, R. L. McGregor 1254, R. L. McGregor and P. H. Humfeld 18.

52. Cladonia furcata (Huds.) Schrad.
Labette Co., Willey (1886).

53. Cladonia furcata (Huds.) Schrad. var. racemosa (Hoffm.) Floerke
Growing on sandy and rocky soil in shaded oak-hickory forests: *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 68; *Woodson Co.*, R. L. McGregor and P. H. Humfeld 5, 15.

54. Cladonia furcata (Huds.) Schrad. var. racemosa (Hoffm.) Floerke f. squamulifera Sandst.
Growing on soil in moist wooded areas: *Cherokee Co.*. R. L. McGregor and P. H. Humfeld 69.

55. Cladonia gracilis (L.) Willd. var. dilata (Hoffm.) Vainio f. squamulosa (Schaer.) Sandst.
Growing on sandy soil in oak-hickory forests: *Johnson Co.*, O. S. Fearing 486.

56. Cladonia Grayi Merrill.
Growing on moist soil in oak-hickory forests: *Leavenworth Co.*, O. S. Fearing 79(b).

57. Cladonia Grayi Merrill f. carpophora Evans
Growing on soil in oak-hickory forests: *Leavenworth Co.*, O. S. Fearing 65.

58. Cladonia Grayi Merrill f. cyathiformis Sandst.
Growing on sandstone and moist sandy soil: *Leavenworth Co.*, O. S. Fearing 79(a), R. L. McGregor 1426; *Cherokee Co.*, O. S. Fearing 182, R. L. McGregor 1645, 4400.

59. Cladonia Grayi Merrill f. squamulosa Sandst.
Growing on moist soil in shaded forests: *Wilson Co.*, O. S. Fearing 587.

60. Cladonia piedmontensis Merrill
Growing on sandstone and soil in shaded oak-hickory forests: *Woodson Co.*, O. S. Fearing 146.
61. Cladonia piedmontensis Merrill f. squamulosa Robbins
Growing on sandy soil in open forest: *Woodson Co.*, R. L. McGregor and P. H. Humfeld 16.
62. Cladonia pleurota (Floerke) Schaer.
Growing on sandstone and moist soil in oak-hickory forests: *Chautauqua Co.*, R. L. McGregor 4201, 4391; *Greenwood Co.*, R. L. McGregor and P. H. Humfeld 381; *Leavenworth Co.*, O. S. Fearing 703; *Montgomery Co.*, R. L. McGregor 1780; *Woodson Co.*. R. L. McGregor and P. H. Humfeld 12.
63. Cladonia polycarpa Merrill
Growing on moist soil: *Cherokee Co.*, O. S. Fearing 185.
64. Cladonia pyxidata (L.) Hoffm.
Labette Co., Willey (1886).
65. Cladonia rangiferia (L.) Web.
Labette Co.. Willey (1886).
66. Cladonia robbinsii Evans
Growing on soil in oak-hickory forests: *Woodson Co.*, O. S. Fearing 147(a).
67. Cladonia robbinsii Evans f. squamulosa Evans.
Growing on soil in oak-hickory forests: *Woodson Co.*, O. S. Fearing 147(a).
68. Cladonia strepsilis (Ach.) Vainio
Growing on moist soil in oak-hickory forests: *Cherokee Co.*, O. S. Fearing 191, R. L. McGregor and P. H. Humfeld 11.
69. Cladonia strepsilis (Ach.) Vainio f. coralloideae (Ach.) Vainio
Growing on sandy soil in oak-hickory forest: *Chautauqua Co.*, R. L. McGregor 4198.
70. Cladonia subcariosa Nyl.
Growing on moist soil in oak-hickory forests: *Douglas Co.*, O. S. Fearing 61, R. L. McGregor and P. H. Humfeld 23; *Jefferson Co.*, C. O. Latham 898, O. S. Fearing 706.
71. Cladonia subcariosa Nyl. f. evoluta Vainio
Growing on sandy soil and sandstone in oak-hickory forest: *Douglas Co.*, O. S. Fearing 26, R. L. McGregor and P. H. Humfeld 26.
72. Cladonia subtenuis (Des Abbayes) Evans
Growing on sandy soil in oak-hickory forests: *Chautauqua Co.*, R. L. McGregor 4204, 1207, R. L. McGregor and P. H. Humfeld 17.
73. Dermatocarpon aquaticum (Weis.) Zahlbr.
Growing on limestone: *Anderson Co.*, O. S. Fearing 159; *Douglas Co.*, O. S. Fearing 50; *Miami Co.*, O. S. Fearing 691; *Shawnee Co.*, R. L. McGregor and P. H. Humfeld 144. Growing on sandstone: *Woodson Co.*, R. L. McGregor and P. H. Humfeld 8. Growing on fence post: *Meade Co.*, O. S. Fearing 381.
74. Dermatocarpon cinereum (Pers.) T. Fries
Growing on sandy soil: *Wilson Co.*, R. L. McGregor 1275.
75. Dermatocarpon hepaticum (Ach.) T. Fries
Growing on soil: *Meade Co.*, O. S. Fearing 370.

76. Dermatocarpon miniatum (L.) Mann
Growing in highly shaded areas on limestone rocks: *Anderson Co.*, O. S. Fearing 162; *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 89; *Johnson Co.*, O. S. Fearing 489, P. H. Humfeld and R. L. McGregor 36; *Linn Co.*, R. L. McGregor and P. H. Humfeld 42; *Miami Co.*, O. S. Fearing 682, 693.

77. Dermatocarpon miniatum (L.) Mann var. complicatum (Light.) T. Fries
Growing on rocky soil: *Douglas Co.*, R. L. McGregor and P. H. Humfeld 152.

78. Dermatocarpon rufescens (Ach.) T. Fries
Growing on caliche and soil: *Bourbon Co.*, Gier 2325; *Coffee Co.*, O. S. Fearing 331; *Crawford Co.*, Gier 2366; *Hodgeman Co.*, R. L. McGregor 4618; *Logan Co.*, O. S. Fearing 432; *Meade Co.*, O. S. Fearing 286, 370, 372, 364; *Norton Co.*, O. S. Fearing 410; *Wilson Co.*, R. L. McGregor and P. H. Humfeld 13, 14.

79. Graphis scripta (L.) Ach.
Labette Co., Cragin (1885). Growing on hickory bark: *Anderson Co.*, O. S. Fearing 159(c); *Doniphan Co.*, O. S. Fearing 70; *Jefferson Co.*, O. S. Fearing 643; *Leavenworth Co.*, O. S. Fearing 70, 63(a), 73(b); *Miami Co.*, O. S. Fearing 672(a), 688, 674, 672. Growing on oak bark: *Miami Co.*, O. S. Fearing 675(a), 680.

80. Lecanora atra (Huds.) Ach.
Growing on sandstone: *Kiowa Co.*, O. S. Fearing 396.

81. Lecanora atriseda (E. Fries) Nyl.
Growing on caliche: *Meade Co.*, O. S. Fearing 373.

82. Lecanora badia (Hoffm.) Ach.
Growing on limestone: *Douglas Co.*, O. S. Fearing 42; *Jefferson Co.*, O. S. Fearing 307, 325.

83. Lecanora calcarea (L.) Nyl.
Kansas: Cragin (1885).

84. Lecanora cinerea (L.) Röhling.
Growing on limestone: *Anderson Co.*, O. S. Fearing 161(a), 164(a).

85. Lecanora contorta (Hoffm.) Stiz.
Kansas: Willey (1886).

86. Lecanora cupressi Tuck.
Growing on bark of dead elm: *Phillips Co.*, O. S. Fearing 101(a); *Rooks Co.*, O. S. Fearing 108(a).

87. Lecanora deplanans Nyl.
Growing on sandstone: *Clark Co.*, O. S. Fearing 395(b).

88. Lecanora dispersa (Pers.) Röhl.
Growing on concrete: *Morris Co.*, O. S. Fearing 253, 154(b). Growing on limestone: *Riley Co.*, O. S. Fearing 288; *Jefferson Co.*, O. S. Fearing 475. Growing on conglomerate rocks: *Osborne Co.*, O. S. Fearing 115. Growing on limestone: *Dickinson Co.*, O. S. Fearing 235. Growing on sandstone: *Kiowa Co.*, O. S. Fearing 402(a).

89. Lecanora hageni Ach.
Kansas: Cragin (1885). Growing on limestone: *Jefferson Co.*, O. S. Fearing 316.

90. Lecanora melaena (Hedlund) Fink.
Growing on sandstone: *Leavenworth Co.*, O. S. Fearing 80; R. L. McGregor and P. H. Humfeld 48.
91. Lecanora melanaspis Ach.
Kansas: Cragin (1885). Fink (1935).
92. Lecanora muralis (Schreb.) Rabh.
Growing on limestone: *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 87; *Jefferson Co.*, O. S. Fearing 473.
93. Lecanora muralis (Schreb.) Rabh. var. saxicola (Poll.) Tuck.
Kansas: Cragin (1885).
94. Lecanora polytropa (Ehrh.) Rabh.
Growing on sandstone: *Clark Co.*, O. S. Fearing 395(a); *Douglas Co.*, O. S. Fearing 16; *Ellsworth Co.*, O. S. Fearing 283. Growing on volcanic rocks: *Meade Co.*, O. S. Fearing 378. Growing on caliche: *Hodgeman Co.*, O. S. Fearing 344.
95. Lecanora rubina (Vill.) Ach.
Kansas: Willey (1886). Growing on sandstone: *Ellsworth Co.*, O. S. Fearing 275, 274(b); *Greenwood Co.*, O. S. Fearing 154.
96. Lecanora rugosa (Pers.) Nyl.
Growing on rocks and stones: *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 55.
97. Lecanora subfusca (L.) Ach.
Kansas: Willey (1884).
98. Lecanora subfusca (L.) Ach. var. coilocarpa Ach.
Growing on sandstone: *Douglas Co.*, O. S. Fearing 8.
99. Lecanora varia (Hoffm.) Ach.
Growing on the bark of dead elm: *Rooks Co.*, O. S. Fearing 114. Growing on exposed oak roots: *Leavenworth Co.*, O. S. Fearing 66(b).
100. Lecanora versicolor (Pers.) Ach.
Kansas: Cragin (1885); Fink (1935). Growing on sandstone: *Ellsworth Co.*, O. S. Fearing 503; *Barton Co.*, R. L. McGregor 4633, 4634; *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 98; *Miami Co.*, O. S. Fearing 650; *Ottawa Co.*, O. S. Fearing 132; *Wilson Co.*, O. S. Fearing 592. Growing on caliche: *Hodgeman Co.*, O. S. Fearing 349; *Logan Co.*, O. S. Fearing 425; *Phillips Co.*, O. S. Fearing 107, 104, 106; *Scott Co.*, O. S. Fearing 534, 437(a). Limestone: *Cherokee Co.*, M. Brewster (Fall 1950); *Clark Co.*, O. S. Fearing 391(c), 394(a); *Johnson Co.*, O. S. Fearing 486, 487; *Pottawatomie Co.*, O. S. Fearing 296; *Riley Co.*, O. S. Fearing 293; *Shawnee Co.*, O. S. Fearing 104, 237. Imported granite: *Kiowa Co.*, O. S. Fearing 545. Volcanic rock and ash: *Meade Co.*, O. S. Fearing 375, 376, 377.
101. Lecidea coarctata (J. E. Smith) Nyl.
Growing on sandstone: *Douglas Co.*, O. S. Fearing 8.
102. Lecidea cyanea (Ach.) Röhling.
Growing on sandstone: *Anderson Co.*, O. S. Fearing 161(c); *Chautauqua Co.*, R. L. McGregor 4194.
103. Lecidea leucophaeoides Nyl.
Growing on sandstone: *Neosho Co.*, O. S. Fearing 172.

104. Lecidea lithophila Ach.
Growing on limestone: *Pottawatomie Co.*, O. S. Fearing 297.

105. Lecidea tessellina Tuck
Kansas: Fink (1935).

106. Parmelia borreri Turner
Growing on limestone: *Chautauqua Co.*, O. S. Fearing 607. Growing on moist soil: *Linn Co.*, O. S. Fearing 205(b). Growing on sandstone and soil: *Ellsworth Co.*, O. S. Fearing 265; *Woodson Co.*, R. L. McGregor and P. H. Humfeld 9. Growing on *Quercus sp.* bark: *Doniphan Co.*, O. S. Fearing 319; *Jefferson Co.*, O. S. Fearing 642. Growing on oak and elm bark: *Atchison Co.*, O. S. Fearing 221(a); *Doniphan Co.*, O. S. Fearing 343(c); *Douglas Co.*, O. S. Fearing 6, 27; *Woodson Co.*, O. S. Fearing 137.

107. Parmelia centrifuga (L.) Ach.
Growing on sandstone and soil: *Chautauqua Co.*, O. S. Fearing 602.

108. Parmelia cetrata Ach.
Growing on sandstone: *Wilson Co.*, O. S. Fearing 571; *Woodson Co.*, O. S. Fearing 595; R. L. McGregor and P. H. Humfeld 9. Growing on soil: *Cherokee Co.*, O. S. Fearing 196.

109. Parmelia conspersa (Ehrh.) Ach.
Growing on sandstone, rarely on sandy soil: *Chautauqua Co.*, R. L. McGregor 1203, 4394, R. L. McGregor and P. H. Humfeld 90; *Douglas Co.*, O. S. Fearing 4, 7, R. L. McGregor 2629; *Ellsworth Co.*, O. S. Fearing 276, R. L. McGregor 132, R. L. McGregor and P. H. Humfeld 432; *Kiowa Co.*, O. S. Fearing 401(a), 403; *Wilson Co.*, O. S. Fearing 507, 573, R. L. McGregor and P. H. Humfeld 110.

110. Parmelia crinita Ach.
Growing on sandstone in oak forest: *Wilson Co.*, O. S. Fearing 150.

111. Parmelia molliuscula Ach.
Growing on sandstone: *Barton Co.*, R. L. McGregor 5632; *Douglas Co.*, R. L. McGregor 2628, O. S. Fearing 11; *Jefferson Co.*, R. L. McGregor and P. H. Humfeld 131.

112. Parmelia rudecta Ach.
Growing on the bark of elm, oak, bald cypress, hackberry, and rarely on sandstone: *Douglas Co.*, O. S. Fearing 38(b), 28; *Franklin Co.*, R. L. McGregor 3608; *Jefferson Co.*, O. S. Fearing 639; *Johnson Co.*, O. S. Fearing 483; *Linn Co.*, R. L. McGregor and P. H. Humfeld 47; *Montgomery Co.*, O. S. Fearing 174; *Miami Co.*, R. L. McGregor and P. H. Humfeld 155, O. S. Fearing 663; *Neosho Co.*, O. S. Fearing 167; *Wilson Co.*, R. L. McGregor and P. H. Humfeld 114; *Woodson Co.*, O. S. Fearing 575.

113. Parmelopsis placorodia (Ach.) Nyl.
Growing on bark of *Carya glabra: Miami Co.*, O. S. Fearing 657.

114. Peccania kansana (Tuck.) Forss.
Kansas: Willey (1886), Fink (1935).

115. Peltigera canina (L.) Willd.
This lichen grows on sandy clay soils found predominantly in the oak-hickory forests of eastern Kansas. It can be found also growing over moist sandstone and rarely on limestone: *Anderson Co.*, O. S. Fearing (Summer 1950); *Chautauqua Co.*, R. L. McGregor 1206; *Douglas*

Co., R. L. McGregor and P. H. Humfeld 25, O. S. Fearing 56; *Franklin Co.*, R. L. McGregor 3312; *Greenwood Co.*, R. L. McGregor and P. H. Humfeld 382; *Leavenworth Co.*, O. S. Fearing 75; *Shawnee Co.*. L. D. Volle 1949; *Woodson Co.*, R. L. McGregor and P. H. Humfeld 278.

116. Pertusaria lecanina Tuck.
Growing on hickory bark: *Leavenworth Co.*, O. S. Fearing 73(a).

117. Pertusaria leioplaca (Ach.) Lam. and DC.
Growing on sandstone rocks: *Woodson Co.*, R. L. McGregor and P. H. Humfeld 6.

118. Pertusaria multipuncta (Turn.) Nyl.
Growing on the bark of *Amelanchier canadensis: Chautauqua Co.*, R. L. McGregor 4190. Growing on the bark of *Carya glabra: Douglas Co.*, O. S. Fearing 5, 43(b); *Leavenworth Co.*, O. S. Fearing 46(a), 71; *Nemaha Co.*, O. S. Fearing 232(a).

119. Pertusaria nolens Nyl.
Growing on sandstone: *Leavenworth Co.*, O. S. Fearing 94.

120. Pertusaria pertusa (L.) Tuck.
Kansas: Willey (1884).

121. Physcia adglutinata (Floerke) Nyl.
Kansas: Willey (1884). Growing on dead hackberry bark: *Dickinson Co.*, O. S. Fearing 255. Growing on *Celtis occidentalis* bark: *Jewell Co.*, O. S. Fearing 123(b). Growing on limestone: *Miami Co.*, O. S. Fearing 684.

122. Physcia astroidea (Clem) Nyl.
Growing on the bark of elm: *Cherokee Co.*, M. Brewster (Spring 1950). Growing on *Quercus muhlenbergii* bark: *Doniphan Co.*, O. S. Fearing 227, 228. Growing on the bark of elm: *Osage Co.*, R. L. McGregor and P. H. Humfeld 312.

123. Physcia caesia (Hoffm.) Hampe
Growing on the bark of *Quercus* sp.: *Jefferson Co.*, O. S. Fearing 627.

124. Physcia crispa (Pers.) Nyl.
Growing on the bark of *Carya glabra: Miami Co.*, O. S. Fearing 667.

125. Physcia obscura (Ehrh.) Hampe
Kansas: Willey (1884). Growing on the bark of *Quercus muhlenbergii: Doniphan Co.*, O. S. Fearing 229(b). Growing on walnut bark: *Jefferson Co.*, O. S. Fearing 306. Growing on the bark of ash: *Miami Co.*, O. S. Fearing 163(a). Growing on elm bark: *Morris Co.*, O. S. Fearing 251. Growing on dead bark: *Labette Co.*, O. S. Fearing 246.

126. Physcia pulverulenta (Schreb.) Nyl.
Growing on sandstone: *Douglas Co.*, O. S. Fearing 29. Growing on limestone: *Chautauqua Co.*, O. S. Fearing 506; *Miami Co.*, P. H. Humfeld and R. L. McGregor 217.

127. Physcia setosa (Ach.) Nyl.
Growing on *Quercus* sp. bark: *Miami Co.*, O. S. Fearing 660.

128. Physcia stellaris (L.) Nyl.
This lichen grows on almost all kinds of tree bark throughout the state. It rarely may be found growing on sandstone. *Brown Co.*,

O. S. Fearing 230, 231. *Chautauqua Co.*, O. S. Fearing 578. *Crawford Co.*, O. S. Fearing 203. *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 70, M. Brewster (Spring 1950). *Doniphan Co.*, O. S. Fearing 225, 226. *Douglas Co.*, O. S. Fearing 38(a), 3, 10, 17, 19(a), 34, 628, R. L. McGregor and P. H. Humfeld 135, R. L. McGregor 2631, 2631. *Ellsworth Co.*, O. S. Fearing 263. *Franklin Co.*, R. L. McGregor and P. H. Humfeld 206, 205(a), 171, 207, 203, R. L. McGregor 3609. *Jefferson Co.*, O. S. Fearing 636, 634, 630, 633(b). *Leavenworth Co.*, O. S. Fearing 63(c). *Linn Co.*, R. L. McGregor and P. H. Humfeld 45. *Neosho Co.*, O. S. Fearing 173. *Osage Co.*, R. L. McGregor and P. H. Humfeld 135, 311, O. S. Fearing 244, 243. *Miami Co.*, R. L. McGregor and P. H. Humfeld 220, 163, O. S. Fearing 673, 678, 687. *Ottawa Co.*, R. L. McGregor and P. H. Humfeld 422. *Pottawatomie Co.*, R. L. McGregor and P. H. Humfeld 394. *Phillips Co.*, O. S. Fearing 101(a). *Shawnee Co.*, O. S. Fearing 236, R. L. McGregor and P. H. Humfeld 142, 141. *Woodson Co.*, O. S. Fearing 135.

129. Physcia teretiuscula (Ach.) Lynge
Growing on limestone: *Cherokee Co.*, O. S. Fearing 188, 179, R. L. McGregor and P. H. Humfeld 66. Growing on soil: *Douglas Co.*, O. S. Fearing 21. Growing on sandstone: *Greenwood Co.*, O. S. Fearing 151. Growing on soil: *Johnson Co.*, O. S. Fearing 498. Growing on sandstone: *Woodson Co.*, O. S. Fearing 140(f).

130. Physcia tribacia (Ach.) Nyl.
Growing on elm bark: *Cherokee Co.*, M. Brewster (Spring 1950); Growing on bark of oak: *Cherokee Co.*, O. S. Fearing 197. Growing on *Quercus* sp. bark: *Jefferson Co.*, O. S. Fearing 632. Growing on limestone: *Jefferson Co.*, O. S. Fearing 638. Growing on *Carya glabra: Jefferson Co.*, O. S. Fearing 625. Growing on fence post: *Jefferson Co.*, O. S. Fearing 314. Growing on bark of ash: *Meade Co.*, O. S. Fearing 368. Growing on calcareous soil: *Miami Co.*, O. S. Fearing 691. Growing on the bark of *Carya glabra: Miami Co.*, O. S. Fearing 689, 668. Growing on caliche: *Scott Co.*, O. S. Fearing 443.

131. Physcia virella (Ach.) Flagey
Growing on bark of American elm: *Douglas Co.*, R. L. McGregor and P. H. Humfeld 22. Growing on the bark of *Quercus muhlenbergii: Doniphan Co.*, O. S. Fearing 229(a).

132. Placynthium nigrum (Huds.) S. F. Gray
Kansas: Willey (1886).

133. Protoblastenia rupestris (Scop.) Steiner
Growing on limestone rocks: *Cherokee Co.*, O. S. Fearing 194.

134. Psora demissa (Rutström) Stein.
Growing on soil: *Douglas Co.*, R. L. McGregor 2633; *Wilson Co.*, R. L. McGregor and P. H. Humfeld 116.

135. Psora icterica (Mont.) Müll.
Labette Co., Willey (1886). Growing on sandy soil: *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 103; *Ellsworth Co.*, R. L. McGregor 1306, O. S. Fearing 509; *Rice Co.*, R. L. McGregor 2726.

136. Psora petri (Tuck.) Fink
Growing on sandstone: *Ottawa Co.*, R. L. McGregor and P. H. Humfeld 418.

137. Psora russellii (Tuck.) Schneid.
Barber Co., Willey (1886). Growing on limestone: *Chautauqua Co.*, R. L. McGregor and P. H. Humfeld 88; *Cherokee Co.*, O. S. Fearing 184, R. L. McGregor and P. H. Humfeld 54; *Ellsworth Co.*, O. S. Fearing 513. Growing on caliche: *Hodgeman Co.*, O. S. Fearing 347. Growing on caliche: *Meade Co.*, O. S. Fearing 356, 375. Growing on volcanic ash: *Meade Co.*, O. S. Fearing 379, 380(a). Growing on caliche and sandstone: *Norton Co.*, O. S. Fearing 416(a); *Ottawa Co.*, O. S. Fearing 128. Growing on limestone: *Wilson Co.*, R. L. McGregor and P. H. Humfeld 188, 155.

138. Pyrenopsis viridirufa Tuck.
Kansas: Fink (1935). *Bourbon Co.*, Willey (1886).

139. Pyxine sorediata (Ach.) E. Fries
Growing on bark of oak: *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 67. Growing on dead bark: *Cherokee Co.*, R. L. McGregor and P. H. Humfeld 56. Growing on bark on American elm: *Douglas Co.*, R. L. McGrgeor and P. H. Humfeld.

140. Rhizocarpon alboatrum (Hoffm.) Anzi.
Growing on sandstone: *Woodson Co.*, O. S. Fearing 140(e).

141. Rinodinia biatorina Koerb.
Growing on sandstone: *Kiowa Co.*, O. S. Fearing 397(a).

142. Rinodinia bischoffi (Hepp) Mass.
Kansas: Cragin (1885).

143. Rinodinia ocellata (Hoffm.) Arn.
Growing on sandstone: *Douglas Co.*, R. L. McGregor 2630; *Ellsworth Co.*, O. S. Fearing 277, 279. Growing on caliche: *Phillips Co.*, O. S. Fearing 103. Growing on glacial granite: *Pottawatomie Co.*, O. S. Fearing 301, 294. Growing on sandstone: *Wilson Co.*, O. S. Fearing 140(a); *Woodson Co.*, O. S. Fearing 591.

144. Rinodinia oreina (Ach.) Mass.
Kansas: Cragin (1885).

145. Rinodinia radiata Tuck.
Growing on limestone and volcanic ash: *Meade Co.*, O. S. Fearing 363, 365.

146. Rinodinia sophodes (Ach.) Mass.
Kansas: Willey (1884). Growing on tree bark: *Miami Co.*, O. S. Fearing 702.

147. Solorina saccata (L.) Ach.
Growing on rocky cliff exposed to sun: *Logan Co.*, R. L. McGregor 2152.

148. Solorinaria despreauxii (Mont.) Fink
Growing on limestone: *Chautauqua Co.*, O. S. Fearing 601. Growing on sandy soil: *Leavenworth Co.*, R. L. McGregor 1428; *Neosho Co.*, R. H. Thompson.

149. Staurothele clopima (Wahl.) T. Fries
Growing on limestone: *Douglas Co.*, O. S. Fearing 52.

150. Staurothele diffractella (Nyl.) Tuck.
Growing on chalk: *Trego Co.*, R. L. McGregor 3285.

151. Synechoblastus laciniatus (Nyl.) Fink
Kansas: Willey (1886). Kansas: Fink (1935).

152. Synechoblastus pycnocarpus (Nyl.) Müll.
Kansas: Willey (1884).

153. Teloschistes candelarius (L.) Fink
Growing on dead oak bark: *Chautauqua Co.*, R. L. McGregor 4393. Growing on the bark of *Celtis occidentalis: Dickinson Co.*, O. S. Fearing 258. Growing on the bark of cottonwood: *Kingman Co.*, O. S. Fearing 457. Growing on the bark of *Celtis* sp.: *Jewell Co.*, O. S. Fearing 122, 123(a); *Meade Co.*, O. S. Fearing 353. Growing on limestone: *Miami Co.*, R. L. McGregor and P. H. Humfeld 218. Growing on dead elm bark: *Morris Co.*, O. S. Fearing 248; *Norton Co.*, O. S. Fearing 417(b); *Rooks Co.*, O. S. Fearing 108(a).

154. Teloschistes candelarius (L.) Fink var. pygmaeus (Bory.) Fink
Growing on the bark of *Quercus sp.: Butler Co.*, R. L. McGregor 2246; *Douglas Co.*, R. L. McGregor and P. H. Humfeld 134. *Wilson Co.*, P. H. Humfeld 117. Growing on the bark of elm: *Douglas Co.*, R. L. McGregor 2625; *Johnson Co.*, R. L. McGregor and P. H. Humfeld 37. Growing on the bark of *Prunus angustifolia: Harvey Co.*, R. L. McGregor (Summer 1949).

155. Teloschistes chrysophalmus (L.) Beltr.
Kansas: Willey (1884). Growing on the bark of *Quercus sp.: Cowley Co.*, R. L. McGregor 4737, 4742. Growing on dead wood: *Kingman Co.*, O. S. Fearing 454.

156. Teloschistes euploeus (Tuck.) Zahlbr.
Growing on the bark of red cedar: *Barton Co.*, R. L. McGregor 4637. Growing on the bark of elm: *Wabaunsee Co.*, R. L. McGregor 1858.

157. Teloschistes polycarpus (Ehrh.) Tuck.
Growing on *Quercus sp.* bark: *Anderson Co.*, O. S. Fearing 166; *Douglas Co.*, O. S. Fearing 627. Growing on *Carya glabra* bark: *Douglas Co.*, O. S. Fearing 2; *Franklin Co.*, R. L. McGregor 204. Growing on the bark of elm: *Franklin Co.*, R. L. McGregor 3607. Growing on the bark of ash: *Maimi Co.*, O. S. Fearing 164.

158. Urceolaria actinostoma Pers.
Kansas: Willey (1886); Fink (1935). Growing on sandstone: *Barton Co.*, R. L. McGregor 4531; *Clark Co.*, O. S. Fearing 391(b). Growing on caliche: *Scott Co.*, O. S. Fearing 539.

159. Urceolaria scurposa (Schreb.) Ach.
Growing on sandstone: *Chautauqua Co.*, O. S. Fearing 614(a); *Douglas Co.*, O. S. Fearing 22, R. L. McGregor 2627; *Ellsworth Co.*, O. S. Fearing 269; *Kiowa Co.*, O. S. Fearing 401(b), R. L. McGregor 3245; *Woodson Co.*, R. L. McGregor and P. H. Humfeld 7.

160. Usnea barbata (L.) Wigg.
Growing on sandstone: *Chautauqua Co.*, R. L. McGregor 4191.

161. Usnea subfusca Stirtion
Growing on sandstone: *Chautauqua Co.*, R. L. McGregor 1204.

162. Usnea variolosa Mot.
Growing on sandstone: *Chautauqua Co.*, O. S. Fearing 604; P. H. Humfeld and R. L. McGregor 92; *Ellsworth Co.*, R. L. McGregor 2725, R. L. McGregor and P. H. Humfeld 433.

163. Verrucaria virens Nyl.
Growing on limestone: *Jefferson Co.*, O. S. Fearing 308.

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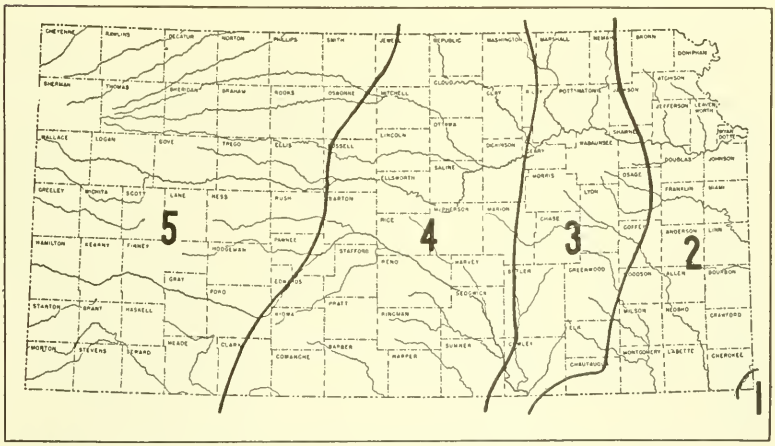

Map showing the areas of the general plant associations in Kansas.

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A Review of the Frogs and Toads of Costa Rica

BY

EDWARD H. TAYLOR *

Abstract: The present known salientian fauna of Costa Rica is reviewed and descriptions are given for the species known to occur in the country. Illustrations of numerous species are given.

The following new forms are described: *Hyla alvaradoi, Hyla rivularis, Hyla immensa, Hyla rufioculis, Hyla alleei, Hyla debilis, Hyla wellmanorum, Hyla angustilineata, Hyla moraviaensis, Bufo holdridgei, Cochranella talamancae, Atelopus senex, Atelopus varius loomisi, Atelopus varius ambulatorius, Microbatrachylus rearki, Microbatrachylus costaricensis, Eleutherodactylus dubitus, Eleutherodactylus crassidigitus.*

Bufo gabbi, a new name, is given for *Bufo auritus* Cope (*nec. Bufo auritus* Raddi). In the genus *Microbatrachylus* are placed certain forms (*polyptychus, underwoodi, bransfordii,* and *stejnegerianus*) heretofore regarded as belonging to the genera *Hylodes, Lithodytes* or *Eleutherodactylus.*

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INTRODUCTION

The present work concerning the frogs and toads is the third of a series treating of the herpetological fauna of Costa Rica. The first dealing with the snake fauna appeared in 1951.* The second dealing with the salamander and caecilian fauna appeared in 1952.** The material on which the present work is based is that of Richard C. Taylor, and that collected by me for the University of Kansas in 1947. This has been augmented by a second collection obtained by me in Costa Rica in 1951.

A report on the extent of the 1947 collections and localities visited appears in the preceding works. The localities at which collections were made in 1951, in some measure duplicate those of 1947; but the greater number of collecting localities was different.

Arriving in San José by air on June 24, 1951, after an uneventful flight, I completed the formalities at the customs, and moved on to Turrialba on June 26. Here at the Inter-American Institute of Agricultural Sciences I established my headquarters, thanks to the courtesy of the director, Dr. Ralph Allee.

From here journeys were made to the slopes of the Volcanoes Barba, Poás and Irazú; to the eastern slope of the northern part of the Talamanca Range, and to the summit of the peak of Cerro de la Muerte. A number of days were spent at Moravia, the great finca of Don Fernando Alvarado-Chacon; at Bataan, the abaca plantations; and at Los Diamantes in the eastern lowlands. An outbreak of yellow fever in the northern lowlands prevented a journey planned to explore the San Carlos region of northern Costa Rica.

The greatest amount of effort in 1951 was devoted to securing amphibians and to this end night sorties were made on approximately two thirds of the nights between July 26 and September 14. This resulted in the discovery of certain new forms and the collecting of considerable numbers of known forms. The region, seemingly richest in species, was that about Moravia. Here in four days collecting 38 species were taken of which 21 were amphibians, six of which were new to my Costa Rican collection.

I am uncertain as to what time of the year one might expect to find the greatest number of species breeding. During the period from the middle of June to September breeding choruses or eggs were found of *Bufo marinus, Hyla elaeochroa* and *Cochranella*

* A Brief Review of the Snakes of Costa Rica. Univ. Kansas Sci. Bull., vol. 34 pt. 1, 1951, Oct. 1, pp. 1-188, pls. 1-23, text figs. 1-7.

** The Salamanders and Caecilians of Costa Rica. Univ. Kansas Sci. Bull., vol. 34, pt. 2, Feb. 15, 1952, pp. 695-791; pls. LXXVI-LXXXVIII; text figs. 1-14.

fleischmanni although groups of males or single males representing numerous species were heard almost every night. After a time a collector comes to recognize most of these calls. However, a number of unrecognized calls, chiefly from high forest trees, suggest the possibility of still other undiscovered species.

In some cases there is doubt as to the application of names. Several of the Cope types are missing and it is not impossible that I have been influenced by names placed on specimens in certain museums.

The list of Central American type specimens mostly from Costa Rica that at one time may have been in the United States National Museum, but which cannot be found today, is as follows:*

Ollotis coerulescens
Crepidius epioticus
Lithodytes florulentus
Lithodytes habenatus
Lithodytes muricinus
Hylodes stejnegerianus
Leptodactylus quadrivittatus
Dendrobates tinctorius vittatus
Hylella chrysops
Hyla cherrei
Hyla microcephala
Hyla p. monticola
Hyla p. moesta
Ranula chrysoprasina
Hypopachus inguinalis

ACKNOWLEDGMENTS

The journey to Costa Rica was made possible by a grant from the University of Kansas Endowment Association, which provided all funds for the undertaking. I am especially grateful for this courtesy. The cordial welcome and assistance of Dr. Ralph Allee, Director of the Inter-American Institute of Agricultural Sciences, is most appreciated. Aside from arranging for my housing facilities, a very adequate laboratory was provided, and he personally contributed specimens, and enlisted the aid of his faculty and workmen to obtain other specimens for me.

Dr. Leslie Holdridge, of the Costa Rican Ministry of Agriculture and of the Inter-American Institute of Agriculture, while I was a guest at his home, provided transportation for visits to the volcanoes of Barba and Poás, where he was pursuing forestry investigations. On these occasions both Dr. Holdridge and his son, Lee Holdridge, collected numerous specimens for me.

I am under deep obligation to Sr. Don Fernando Alvarado-Chacon for the privilege of visiting Moravia. While there I was provided with transportation and shown every possible courtesy, by his manager. To these gentlemen I express my sincere gratitude.

* I am indebted to Dr. Doris Cochran for help in preparing this list.

At Cartago I was permitted to accompany Sr. Mario Gutierrez J. of the Ministry of Agriculture and Mr. John B. Reark, a student of Forestry, on various exploratory journeys to out-of-the-way places in the mountains both north and south of Cartago. I am under special obligation to Mr. Reark for very numerous herpetological specimens that he collected for me.

Others to whom I desire to express my thanks are Sr. Don Claudio Volio, Minister of Agriculture, Sr. Prof. Reubén Torres Rojas, El Conde de Tattenbach, Dr. and Mrs. Frederick Wellman, Mr. Baker, Mr. Johnny Baker, Dr. Juvenal Valerio, Sr. Julio Valerio, Mr. John de Goeijen, Sr. Frank Herrera, Mr. William Lageler and Prof. Marco Tullio Pacheco. To these I am under obligation for specimens, for transportation and other assistance in collecting, and for numerous other courtesies.

The drawings have been made by Mrs. William Halsey, Victor Hogg, Ellinor Loeffelmann, and Thespa Stapoulis.

For the most part they may be regarded as adequate illustrations of the forms described. A few illustrations are taken from other older works and two figures, *Hyla fimbrimembra* and *Hyla richardi*, recently published in my own paper, are reprinted here, thanks to the courtesy of the Editors of Copeia.

History of Collections and Literature

Literature on the frogs and toads of Costa Rica is scattered in numerous books and journals and much of it is somewhat confused, so much so that the application of the proper name to certain of the forms depends upon a re-examination of the existent types by some competent observer. Many of these type specimens are in European Museums and not of easy access. Others are lost. In this paper certain of the names applied are tentative, pending such an examination.

The known Salientian fauna of Costa Rica is smaller in number of species than the snake fauna, but on the other hand it is much larger than the salamander fauna, the proportion of the three, salamander, Salientia, and snakes, being 1:4:5. While considerable exploration has been done in Costa Rica one can be sure that a considerable number of undiscovered or unrecognized forms remain to be discovered. A rather large percentage of the species is known from unique specimens or from a single collection of two or more specimens at the same time and place.

One of the earlier studies dealing with the fauna of Lower Central America is that of Oscar Schmidt (1857). His specimens were

collected by von Warszewicz in Panamá [New Granada] and Bolivia. Brief Latin descriptions of the species studied by Schmidt appeared first. Later a second, more expanded paper was published with several illustrations. The new species from Central America in the preliminary paper are as follows:

Leiuperus sagittifer, New Granada.
Ixalus warschewitschii, New Granada.
Hyla pugnax, Chiriquí "unweit Bocca del Toro."
Hyla splendens, Chiriquí River "unweit Bocca del Toro."
Hyla molitor, Chiriquí River "unweit Bocca del Toro."
Hyla molitor marmorata, Chiriquí River "unweit Bocca del Toro."
Hylodes fitzingeri, New Granada.
Dendrobates speciosus, New Granada.
Dendrobates pumilio, New Granada.
Dendrobates lugubris, New Granada.
Bufo veraguensis, New Granada, (Veragua) by inference.
Bufo simus, New Granada.
Hylaemorphus Dumerilii, New Granada.
Hylaemorphus Bibroni, New Granada.
Phirix pachydermus, New Granada.

This work of Schmidt was followed by another (Schmidt 1857, "Deliciae Herpetologicae Musei Zoologici Cracoviensis") a considerably longer paper dealing with the same material. While repeating the Latin descriptions, he supplies other considerable data. There is some discussion and greater detail is given concerning the type localities. Three plates, bearing 27 figures, are included.

The first paper dealing exclusively with the Costa Rican herpetological fauna was that of Wilhelm Keferstein (1868). He published on the salientian collection obtained in Costa Rica by Prof. K. von Seebach who was in Costa Rica in 1865, chiefly on a geological journey. The following are described or listed from Costa Rica without more specific locality:

Atelopus varius [Lichenstein and von Martens].
Hypopachus Seebachii Keferstein.
Bufo agua Latreille.
Bufo (Chilophryne) sternosignatus Günther.
Bufo (Rhaebo) haematiticus Cope.
Leiyla Güntherii sp. nov.
Hyla Moreletii Duméril.
Dendrobates typographus Keferstein.

At about this time the U. S. National Museum began to receive specimens from Costa Rica, the collectors being Charles N. Riotte and Doctor Van Patten. The specimens received were forwarded to Edward D. Cope at Philadelphia who had recently begun to publish his numerous papers on the Central American faunas. In his "Fourth Contribution to the Herpetology of Tropical America," (Cope 1866) he describes a new genus and the following new species from Costa Rica:

Genus *Colostethus* gen. nov.
Ranula chrysoprasina sp. nov.
Bufo coccifer sp. nov.
Engystoma variolosum sp. nov.

One other new species, *Phyllobates ridens*, was described from San Juan River, Nicaragua, near the northern border of Costa Rica. The Costa Rican specimens were collected by Charles N. Riotte at a point designated as "Arriba," Costa Rica. No such place name can now be located. It has been suggested by Prof. Reubén Torres that the name is intended for "*above*," or "*up high*," perhaps the mountains arising above Cartago or San José. On the other hand it may have been a place name in existence 85 years ago when the collections were made.

Cope continued to study Central American faunas and a series of papers dealing with Costa Rica followed, the more important of which are noted. In (1871) "Ninth Contribution to the Herpetology of Tropical America" he listed from Costa Rica:

Trypheropsis chrysoprasinus Cope.
Atelopus varius.
Bufo.
Smilisca daudinii (*sic*) Duméril and Bibron.
Agalychnis moreletii Duméril.

These specimens were collected by Dr. Van Patten near San José, Costa Rica.

His most important single work is (Cope 1875) "On the Batrachia and Reptilia of Costa Rica." This was based on a collection made by William Gabb, under the auspices of the government of Costa Rica, chiefly in the southeastern portion of the country. Collections were begun near the eastern seaboard and continued along the route travelled to near the summit of Pico Blanco, a mountain which rises to a height of nearly 12,000 ft. It is a region described by Cope as follows:

"The coast region includes a wide belt of swamps and then gradually rises to a height of two hundred feet at 15 miles inland.

From this point the surface rises rapidly, so that at twenty-five miles the elevation is 2500 feet above the sea. The vegetation of the entire region is exceedingly dense. At an elevation of from 5000 to 7000 feet is the region of greatest precipitation; rain falls here, according to Mr. Gabb, on more than two hundred days of the year and heavy fogs are of daily occurrence. The surface is often covered with a deep layer of moss and swamps abound. There is no belt of pines as in Mexico, but the extreme summits of the peaks are covered with a sparse vegetation consisting chiefly of *Artemesia* much like that of the Rocky Mountain region of the United States, with whortleberries, a bamboo-like grass, a stunted tree fern, and scattered tufts of grass."

The following Salientia are listed:

Cranopsis fastidiosus gen. et sp. nov. Slope of Pico Blanco, 2500 ft.

Crepidius epioticus gen. et sp. nov. Pico Blanco, 5000 ft.

Ollotis coerulescens gen. et sp. nov. Pico Blanco, 3000-5000 ft. elevation.

Bufo auritus sp. nov. East coast region.

Bufo valliceps Wiegmann.

Bufo coccifer Cope.

Bufo sternosignatus Günther (no specimens).

Bufo agua Daudin. Eastern coast.

Bufo haematiticus Cope. Sipurio.

Hypopachus variolosus Cope.

Atelopus varius Stannius. Pico Blanco Range.

Dendrobates typographus Keferstein (low country).

Dendrobates tinctorius auratus Girard.

Dendrobates talamancae Cope. Old Harbor on East Coast.

Hyla gabbii sp. nov. Near Sipurio.

Hyla uranochroa sp. nov. Near Sipurio.

Hyla nigripes sp. nov. Higher points on Pico Blanco, chiefly in the rainy zone, 5000 to 7000 ft.

Hyla elaeochroa sp. nov. East foot of mountains near Sipurio.

Hyla punctariola pictipes subsp. nov. Pico Blanco, 5000 to 7000 ft.

Hyla punctariola moesta subsp. nov. Pico Blanco, 5000 to 7000 ft.

Hyla punctariola monticola subsp. nov. Pico Blanco, 5000 to 7000 ft.

Smilisca baudinii Duméril and Bibron.

Agalychnis moreletii A. Duméril.

Phyllobates hylaeformis sp. nov. Pico Blanco, 7000 ft.
Liyla guentherii Keferstein (no specimens).
Lithodytes podiciferus sp. nov. Pico Blanco.
Lithodytes muricinus sp. nov. Pico Blanco.
Lithodytes habenatus sp. nov. Pico Blanco.
Lithodytes melanostictus sp. nov. Pico Blanco, 7000 ft.
Lithodytes megacephalus sp. nov. Pico Blanco, 6000 ft.
Lithodytes gulosus sp. nov. Pico Blanco, 6000 ft.
Hylodes cerasinus sp. nov. Pico Blanco.
Gnathophysa ocellata Linnaeus.
Trypheropsis chrysoprasinus Cope. Uren 2500 ft.
Ranula brevipalmata Cope. Pico Blanco.

Cope's (1877) "Tenth Contribution to the Herpetology of Tropical America," contains the description of *Bufo melanochloris* sp. nov. from east Costa Rica collected by Wm. Gabb. Cope (1875) had at first referred the type specimen to *Bufo valliceps*. Two forms *Lithodytes lanciformis* and *Lithodytes pelviculus* from "West Coast of Central America" are not impossibly from Costa Rica since these names have been synonymized with Costa Rican species.

Cope's (1886) "Thirteenth Contribution to the Herpetology of Tropical America" deals with a collection sent by Dr. J. F. Bransford from Nicaragua. The following are listed:

Hylodes polyptychus sp. nov.
Bufo haematiticus Cope.
Bufo marinus Linnaeus.
Bufo valliceps Wiegmann.
Dendrobates tinctorius Wagler.
Dendrobates typographus Keferstein.
Hypsiboas albomarginata Spix.
Agalychnis helenae Cope.
Lithodytes diastema Cope.
Ranula chrysoprasina Cope.
Engystoma pictiventris sp. nov.
Hyla quinquevittata Cope.
Lithodytes ranoides sp. nov.

All of these species except *Bufo valliceps* are known to occur in Costa Rica, suggesting strongly that the collection was made in southernmost Nicaragua. Two other species are described as new that may or may not occur in Costa Rica. These are, *Hypsiboas miliarius* sp. nov. and *Lithodytes bransfordii* sp. nov. (the latter reported in Costa Rica by Barbour and Dunn, 1921).

In his "Second Addition to the Knowledge of the Batrachia and Reptilia of Costa Rica," Cope (1893) describes four new forms of Salientia and lists several known forms. These are:

Lithodytes florulentus sp. nov. Boruca.
Hylodes stejnegerianus sp. nov. Palmar.
Leptodactylus quadrivittatus, sp. nov. Buenos Ayres.°
Dendrobates tinctorius vittatus subsp. nov. Buenos Ayres.°
Bufo marinus Linnaeus. Buenos Ayres.°
Bufo haematiticus Cope. Rio Grandes, Buenos Ayres.°
Hyla gabbii Cope. Buenos Ayres.° Lagarto.
Hyla nigripes Cope. Buenos Ayres.°
Liohyla ranoides Cope. Terraba, Buenos Ayres.°
Lithodytes rhodopis Cope. Buenos Ayres.°
Dendrobates tinctorius auratus Girard. Palmar, Talamanca.
Atelopus varius Stannius. Palmar.

Cope's last important paper on this fauna was (1894) "Third Addition to a Knowledge of the Batrachia and Reptilia of Costa Rica." Most of the specimens for this study were sent to Cope by the Museo Nacional de Costa Rica. The collectors of the following specimens were R. Alfaro, Sen. P. Biolley, and G. K. Cherrie.

Hyla cherrei sp. nov. Alajuela.
Hylella chrysops sp. nov. Alajuela, and San José.
Lithodytes euryglossus sp. nov. San José.
Levirana vibicaria new genus and species, Rancho Redondo and Isla Nueva, near the head of the Rió Sucio on the Atlantic side.

Oscar Boettger (1892) described *Hyla prosoblepon* from La Junta, near Limón and later (Boettger, 1893) another new species *Hyla fleischmanni* from San José. The specimens were collected by Carl Fleischmann.

G. A. Boulenger published his "Catalogue of the Batrachia Salientia" in 1882, and the Costa Rican material in the British Museum at that time, is listed in this great work. *Phyllomedusa lemur* is described as new from Costa Rica, and *Hylodes palmatus*°° is used for certain frogs from Dueñas, Guatemala. In 1891 he described *Bufo leutkenii* from Cartago, Costa Rica and later (Boulenger, 1896) he described *Hylodes underwoodi* and *Hylella puncticrus.* A salamander *Spelerpes subpalmata* is also described in the same paper. In 1898 (Boulenger, 1898) he reported a series of eleven

° Spelled "Buenos Aires" on recent maps.

°° Although not so stated *Hylodes palmatus* may be a substitute name for *Leiyla guentherii* Keferstein 1868, presumably preoccupied by *Hylodes Güntheri* Steindachner 1864, at least Boulenger places the Keferstein species in the synonymy of *palmatus.*

species. Much of the Costa Rican material in the British Museum was acquired or collected by Mr. C. F. Underwood. This material is later listed in the work by Günther (1900-1902).

Salientia from the collections of Mission Scientifique au Mexique et dans' l'Amérique Centrale, was studied by M. Brocchi who published from 1881-1883. Most of the Costa Rican species listed are those taken from the literature, since the Mission did not collect in the southern part of Central America.

Albert Günther, from February 1900 to May 1902 issued the "Batrachia" section of the "Biologia Centrali-Americana. Reptilia and Batrachia." This great work deals with the Batrachian fauna of Central America (and Mexico) and is perhaps the second most important work on the batrachian fauna of Costa Rica. Approximately 60 species are listed from Costa Rica, most of which were represented in the collections of the British Museum. The presence of five others may be inferred since they occur north and south of Costa Rica. Two species listed (*Hyla godmani* and *Hyla punctariola*) are seemingly questioned as to their occurrence. Many species are figured and the following are listed:

Rana halecina Kalm. Bebedero, San José, La Palma Lagoon to alt. 1500 m.

Rana godmani sp. nov. Río Sucio.

Rana caerulopunctata Steindachner. La Palma 1500 m.

Laevirana vibicaria Cope. Irazú Range and Isla Nueva.

Hylaplesia tinctoria (Schneider). La Palma; Talamanca; Buenos Aires.

Hylaplesia typographa (Keferstein). "Costa Rica."

Hylaplesia talamancae (Cope). "Costa Rica," "Cold Harbour" on the east coast.

Atelopus varius Stannius. Bebedero; Escazú; "Izaru" [= Irazú?]; San Marcos; Tivas (alt. 1000 m.); Santa Clara (alt. 400 m.).

Glossostoma aterrimum sp. nov. "Costa Rica."

Hypopachus variolosus (Cope). Bebedero; San José.

Leptodactylus pentadactylus Laurenti. Eastern Costa Rica; Las Delicias; Santa Clara (400 m.).

Leptodactylus caliginosus Girard. "Costa Rica."

[*Syrrhaphus ridens* (Cope)] reported from Nicaragua and Panamá.

Syrrhaphus hylaeformis (Cope). Pico Blanco.

Liohyla guentheri (Keferstein). "Costa Rica"; Río Ceibo; Buenos Aires.

Liohyla bocourti (Brocchi). Río Sucio.
Liohyla fleischmanni (Boettger). La Palma; San José; Iscazú.
Liohyla pittieri sp. nov. "Costa Rica"; Boruca.
Liohyla engytympanum sp. nov. Monte Redondo.
Liohyla ranoides (Cope). Buenos Aires; Terraba.
Hylodes polyptychus Cope. La Palma.
Hylodes underwoodi Boulenger. La Palma (1600 m. alt.).
Hylodes platyrhynchus sp. nov. "Costa Rica."
Hylodes cerasinus Cope. La Palma; ? Pico Blanco.
Hylodes euryglossus (Cope). San José.
Hylodes rhodopis (Cope). Pico Blanco; Buenos Aires; La Palma; Cartago, ?Irazú.
[*Hylodes rugosus* Peters]. Nicaragua and Panamá.
Hylodes florulentus (Cope). Boruca.
Hylodes melanostictus (Cope). Pico Blanco.
Hylodes brocchii (Boulenger) Brocchi. La Palma (alt. 1600 m.).
Hylodes nubilus sp. nov. Escazú.
Hylodes megacephalus (Cope). Las Delicias; Santa Clara (alt. 500 m.); Pico Blanco.
[*Hylodes diastema* (Cope)]. Nicaragua and Panamá.
Hylodes gulosus (Cope). Pico Blanco (alt. 6000 ft.).
[*Engystomops pustulosus* Cope]. Mexico and Panamá.
Bufo haematiticus Cope. Talamanca; Santo Domingo; Golfo Dulce; Las Minas; Río San Juan.
[*Bufo sternosignatus* Günther]. ?(Costa Rica).
Bufo marinus (Linnaeus). "Costa Rica."
Bufo coccifer Cope. Vicinity San José; Laguna de la Palma.
Bufo coniferus Cope. La Palma; Carillo.
Bufo valliceps Wiegmann. "Costa Rica."
Bufo melanchloris Cope. Eastern Costa Rica.
Bufo leutkenii Boulenger. Cartago.
Bufo auritus Cope. Talamanca.
Nannophryne fastidiosa (Cope). Pico Blanco (alt. 2500 m.).
Nannophryne epiotica (Cope). Pico Blanco.
Nannophryne coerulescens (Cope). Pico Blanco (alt. 3000 to 5000 ft.).
Hyla cherrii Cope. Alajuela.
Hyla elaeochroa Cope. Sipurio.
Hyla baudini Duméril and Bibron. Cariblanco de Serapiquí; La Hondura.
Hyla venulosa (Laurenti). Bebedero.

Hyla gabbi Cope. Sipurio; La Palma; Monte Rotundo (alt. 1600 m.); Laguna de la Palma; Cartago; San José.
Hyla pseudopuma sp. nov. La Palma (alt. 1600 m.).
?*Hyla godmani* sp. nov. La Palma (also Mexico).
Hyla uranochroa Cope. Río Sucio; La Palma (alt. 1600 m.).
Hyla leucophyllata Beiris. Costa Rica.
Hyla underwoodi Boulenger. Bebedero.
Hyla nigripes Cope. "Costa Rica."
Hyla prosoblepon Boettger. Limón; La Palma.
[*Hyla punctariola* Peters]. ?Costa Rica.
Hyla albomarginata Spix. San Carlos.
Hylella fleischmanni Boettger. San José; La Palma; Alajuela.
?*Nototrema oviferum* (Weinland). Carrillo.
Agalychnis moreletii (A. Duméril). Cartago and Irazú; Escazú; San José.
[*Agalychnis callidryas*] (Cope). Mexico; Panamá.
Agalychnis helenae Cope. San Carlos.
Agalychnis lemur (Boulenger). "Costa Rica."

In 1920 Emmett Dunn, then a collector for Tom Barbour, and the Museum of Comparative Zoology, began work in Costa Rica, and later made other collecting journeys to that country. Three Costa Rican forms from this first collection are described by Barbour and Dunn (1921): *Syrrhophus lutosus* Navarro, Costa Rica, *Phyllobates beatriciae* Victoria Farm near Zent, and *Eleutherodactylus noblei*, Guápiles, Costa Rica and San Miguel Island, Panamá Bay. Other specimens reported are *Phyllobates talamancae* (Cope), Santa Cecilia; *Eleutherodactylus bransfordi* (Cope), Orotino, Guápiles and Zent; *E. ceresinus* (Cope) (*sic*), Zent; *E. diastemma* (*sic*) (Cope), Monteverdo; *E. fleishmanni* (*sic*) (Boettger) Saint Cecilia, Guápiles, La Palma and Cariblanco; *E. lanciformis* (Cope), Navarro and Guápiles; *E. polyptychus* (Cope), Monteverde and Guápiles; *E. rhodopis* (Cope), Camino del Río; *E. rugosus* (Peters), Monteverde.

In a later paper Barbour (1926) described *Eleutherodactylus persimilis* from a collection made by Dunn and Chester Duryea. Barbour later (1928) described a series of species as follows: *Eleutherodactylus peraltae* and *Hyla lancasteri* from Peralta, Costa Rica. *Syrrhophus caryophyllaceus* described from La Loma, Panamá is known to occur in Costa Rica. Several other forms were described from Panamá. In certain of Dunn's papers dealing primarily with the fauna of Panamá, species are reported from Costa Rica also.

Dunn (1931c) reports on some Costa Rican materials, and the following are described as new: *Eleutherodactylus talamancae,* Almirante and La Loma, Panamá; Monteverde, Zent and Suretka, Costa Rica; *Lithodytes gaigei,* Fort Randolph, Barro Colorado Island, Canal Zone; Talamanca Valley, Costa Rica; *Phyllobates flotator,* Barro Colorado Island, Canal Zone; Costa Rica to Darien; *Centrolene valerioi,* La Palma, Costa Rica, 4500 ft. *Hyla colymba* is described from Panamá. Several other species are listed as occurring in Costa Rica. Later (Dunn 1937) described *Hyla picadoi,* a new species, from Volcán Barba and El Gallito, Costa Rica, and certain other species are listed as occurring in bromelias of Costa Rican forests. In 1942 he described *Eleutherodactylus altae* from the pass between Volcán Barba and Volcán Irazú, at approximately 4000 ft. elevation.

In 1934 Otto Wettstein published on Costa Rican materials obtained by R. Zimara and Dr. Otto Koller in a number of Costa Rican localities. The expedition collected 78 herpetological species and subspecies (256 specimens) of which there were three species of salamanders and 17 species and subspecies of frogs and toads. No new species or subspecies are described. The following are listed:

Rana pipiens Schreber. Finca Guayabillos 2200 m. on Volcán Irazú.

Rana warschewitschii O. Schmidt. San Isidro de Coronada 1650 m.; La Carpintera, Volcán Irazú.

Dendrobates auratus Girard. Finca Hamburg am Río Reventazón.

Dendrobates pumilio O. Schmidt. Finca Hamburg, Carillo.

Atelopus varius varius Lichtenstein and von Martens. La Carpintera.

Bufo haematiticus Cope. La Caja near San José.

Bufo valliceps Wiegmann. Bebedero.

Bufo coccifer Cope. San José.

Hyla baudinii Duméril and Bibron. Tilleran, 520 m. San Isidro de Coronada.

Hyla albomarginata Spix. Finca Hamburg.

Centrolene (= *Hyla*) *prosoblepon* Boettger. San Isidro de Coronada, Volcán Irazú.

Phyllomedusa (=*Agalychnis*) *callidryas* Cope. Port Limón.

Eleutherodactylus gollmeri Peters. La Carpintera.

Eleutherodactylus melanostictus Cope. Volcán Irazú.
Eleutherodactylus polyptychus Cope. La Carpintera.
Cystignathus (= *Leptodactylus*) *quadrivittatus* Cope. Río Nuevo near Porto Jiménez.

In 1947 Richard Clark Taylor and I made a journey to Costa Rica, remaining there for three summer months. Rather extensive collections of reptiles and amphibians were made in various parts of the country. In 1951 I undertook a second journey, this time spending there a little more than two and a half months. The aggregate of these three collections is approximately 6000 specimens (more than half of which are amphibians) a number possibly equaling all preceding collections.

Two preliminary papers were published. These are: (Taylor 1948) in which are described *Hyla fimbrimembra,* Volcán Poás, and *Hyla richardi,* Volcán Poás. In Taylor (1949) four species of Costa Rican frogs are described. These are: *Centrolenella spinosa,* Los Diamantes; *Centrolenella granulosa,* Los Diamantes; *Centrolenella albomaculata,* Los Diamantes and *Centrolenella colymbiphyllum,* Volcán Poás.

The material in these collections is treated in this present work and several other species, regarded as new, are herein described.

The new species and subspecies include the following:

Bufo holdridgei, Volcán Barba, 7500 ft. elev.; *Microbatrachylus rearki,* Bataan, Los Diamantes and Turrialba; *Microbatrachylus costaricensis,* Morehouse Finca, near Turrialba; *Eleutherodactylus dubitus,* Isla Bonita, Volcán Poás; *Eleutherodactylus crassidigitus,* Isla Bonita, Volcán Poás; *Hyla alvaradoi,* Moravia; *Hyla rivularis,* Isla Bonita, Volcán Poás; *Hyla immensa,* Turrialba; *Hyla rufiocula,* Isla Bonita, Volcán Poás; (also Morehouse Finca near Turrialba and Moravia); *Hyla alleei,* Isla Bonita, Volcán Poás; *Hyla debilis,* Isla Bonita, Volcán Poás; *Hyla wellmanorum,* Bataan, *Hyla angustilineata* La Palma; *Hyla moraviaensis,* Moravia; *Cochranella talamancae,* Moravia; *Atelopus senex, Atelopus varius loomisi, Atelopus varius ambulatorius,* Volcán Poás.

Bufo gabbi, a new name, is given for *Bufo auritus* Cope (*nec. Bufo auritus* Raddi).

CLASSIFICATION

DISTRIBUTION OF SUBORDERS AND FAMILIES OF SALIENTIA IN THE WESTERN HEMISPHERE

Amphicoela ..... Liopelmidae. Northwestern United States.

Opisthocoela .....
- Rhinophrynidae. Mexico.
- Pipidae. South America.

Anomocoela ..... Pelobatidae. North America to southern Mexico.

Procoela .....
- Bufonidae. North, Central and South America.
- Brachycephalidae. Central and South America.
- Leptodactylidae. Mexico, Central and South America.
- Centrolenidae. Mexico, Central and South America.
- Hylidae. North, Central and South America.

Diplasiocoela .....
- Microhylidae. North, Central and South America.
- Ranidae. North and Central America (barely entering South America).

DISTRIBUTION OF COSTA RICAN GENERA OF SALIENTIA IN THE WESTERN HEMISPHERE

	United States	Mexico	Guatemala	Costa Rica	Panamá	South America
Bufo	X	X	X	X	X	X
Atelopus				X	X	X
Phyllobates				X	X	X
Dendrobates				X	X	X
Eleutherodactylus	X	X	X	X	X	X
Leptodactylus	X	X	X	X	X	X
Eupemphix		X	X	X	X	X
Microbatrachylus		X	X	X	X	?
Centrolene				X	X	X
Cochranella		X	X	X	X	X
Teratohyla				X	?	?
Hyla	X	X	X	X	X	X
Anotheca		X	?	X		
Acrodytes		X	X	X	X	X
Smilisca	X	X	X	X	X	X
Agalychnis		X	X	X	X	X
Phyllomedusa				X	?	X
Hypopachus	X	X	X	X	?	X
Microhyla	X	X	X	X	X	X
Rana	X	X	X	X	X	X

At least three South American salientian genera reach Panamá, which may or may not be found eventually in Costa Rica. These are *Prostherapis*, *Hemiphractus*, and *Elachistocleis*.

FAMILY BUFONIDAE

Bufonidae Hogg, Ann. Mag. Nat. Hist., ser. 2, vol. 7, 1841, p. 361.

This family comprises groups of amphibians commonly designated toads, but this common term is likewise often applied to

amphibians of other families whose bodies are squat and whose movements are slow. In Spanish-speaking countries the members of the family are usually called *sapo*.

In the groups of the Family Bufonidae represented in the Costa Rican fauna, here recognized under the genus *Bufo*, certain of the species, having a relatively wide distribution, are well known; while several others still are known from the types only, or at least from very few specimens. In the former group are *Bufo haematiticus* Cope, *Bufo marinus* Linnaeus, *Bufo coccifer* Cope, and *Bufo coniferus* Cope. In the latter are *Bufo fastidiosus* Cope, *Bufo gabbi nov. nom.* (for *Bufo auritus* preoccupied), *Bufo leutkenii* Boulenger, *Bufo epioticus* Cope, *Bufo melanochloris* Cope, *Bufo coerulescens* Cope, and *Bufo holdridgei sp. nov.*

Certain other species occur in neighboring areas north and south of Costa Rica and some of these very probably will eventually be found within the borders of Costa Rica. In this group may be listed *Bufo politus* Cope, from Nicaragua; *Bufo simus* Schmidt, *?Bufo granulosus* Spix, *Bufo typhonius* (Linnaeus), and *Bufo veraguensis* Schmidt from Panamá.

The species represent diverse groups, certain of which have been placed—perhaps correctly—in genera other than *Bufo*. However the effect of Boulenger's treatment of these genera in his "Catalogue of the Batrachia Salentia" has been so far-reaching that many of these genera are now not recognized because they were synonymized with *Bufo*.

The following generic names have been proposed by Cope and others:

Rhaebo Cope	*Bufo haematiticus*
Bufo Laurenti	*Bufo politus*
Phrynoidis Fitzinger	*Bufo marinus*
Otilophis Cope	*Bufo typhonius*
Cranophryne Cope	*Bufo fastidiosus* *Bufo simus*
Crepidophryne Cope	*Bufo epioticus*
Ollotis Cope	*Bufo coerulescens*
Incilius Cope	*Bufo veraguensis* *Bufo granulosus* *Bufo coccifer* *Bufo coniferus* *Bufo leutkenii* *Bufo melanochloris* *Bufo gabbi*

The seeming rarity of so many species of toads is perhaps purely a matter of lack of collecting at the proper time. If the collector chances to come upon a population during the breeding period the species may be seemingly "common"; at almost any other season of the year few or no individuals may be encountered and it is "rare." In the case of the toads originating on Pico Blanco, Costa Rica, their apparent rarity is, first of all, due to the fact that the type locality has not been revisited. There is a probability that the fauna is of very limited distribution; otherwise one might expect certain of the rare species to appear in collections obtained elsewhere in Costa Rica and Panamá.

References appear in literature to certain other species as occurring in Costa Rica.

Bufo valliceps Cope. A specimen of *Bufo* was referred to this species by Cope (1875). Later he based a new species, *Bufo melanochloris,* on the same specimen.

Otto Wettstein (1934) has again listed *Bufo valliceps* from Costa Rica (Bebedero); but it is possible that this record represents an error of identification since he comments that perhaps *Bufo canaliferus, Bufo marmoratus, Bufo coccifer,* and *Bufo valliceps* will be found to be races of the same species! I regard this suggestion as highly improbable since two or three of these forms are found together in certain areas where they occur. *Bufo marmoratus* occurs in Mexican territory with *valliceps* and *coccifer;* and *canaliferus* occurs with *valliceps* and *coccifer.* It is not impossible that all four occur together in the Tehuantepec area.

Bufo sternosignatus is listed by Keferstein (1868) from Costa Rica, in a report on a collection made by Prof. K. von Seebach in 1865. This reference has been placed by Boulenger (1882) with *sternosignatus* Günther. However, some of Günther's *sternosignatus* were confused with *valliceps* and part of Günther's syntypes are referred to *valliceps* by Boulenger. Keferstein may have had Cope's *melanochloris,* which Cope himself, at first, regarded as *valliceps.* A form of *valliceps* actually may occur, or *sternosignatus* may occur. Keferstein distinctly states that the characteristic marking, from which the name is derived, a cross on the breast, is in evidence in his specimen called *sternosignatus.* In view of the uncertainty of this identification, I am considering *sternosignatus* as a doubtful member of the fauna until it is rediscovered.

Genus BUFO Laurenti

Bufo Laurenti, Specimen medicum, exhibens Synopsin Reptilium . . ., Viennae, 1768, p. 25 (type of genus *Bufo vulgaris*).

Eleven species are recognized as occurring in Costa Rica.

KEY TO THE COSTA RICAN SPECIES OF BUFO

1. Head lacking the typical series of cranial crests 2
   Head with a series of elevated cranial crests 4
2. Larger (to 75 mm.); tympanum present, its diameter half length of eye; ostia pharyngea (openings of eustachian tubes) present; parotoid glands elongate, angulate; body dorsolaterally angulate; toes scarcely webbed; skin soft or slightly rough, with only minute tubercles; widespread in central Costa Rica . . . . . *haematiticus*
   Smaller (under 40 mm.); tympanum absent; no ostia pharyngea; no vocal sacs or slits 3
3. Feet almost completely webbed, the fourth toe extending beyond web; inner digits of both hand and foot rudimental; 35 mm.; Pico Blanco, C. R., 5000 ft. elev. . . . . *epioticus*
   All digits without web; inner digits not rudimental; 25 mm.; Pico Blanco, C. R., between 2000 to 5000 ft. elev. . . . *coerulescens*
4. Tympanum present 5
   Tympanum absent 6
5. Tympanic area covered by a bony rugose plate; ostia pharyngea absent; no vocal sac or vocal slits in males; no discrete dorsolateral stripes; a black throat spot; Pico Blanco, C. R., (District of Uren) 2500 ft. elev. . . . . *fastidiosus*
   Tympanum area not covered by a lateral bony plate; ostia pharyngea, vocal sac and vocal slits absent; a discrete dorsolateral stripe; no black throat spot; 7000 ft., Volcán Poás, C. R. . . . . *holdridgei*
6. Diminutive species (31 mm.) lacking a preorbital crest; parotoid surmounted by dermal spines; heel to snout tip; toes half webbed, auricular region with a strongly projecting shelf; only anterior part of tympanum visible; "East coast region," Costa Rica . . . . . *gabbi*
   Larger species (above 50 mm.); preorbital crest present; parotoids not surmounted by dermal spines; heel does not reach eye; no strongly projecting shelf, *or* if present reduced and heel reaching only to eye 7
7. Large toads reaching 200 mm. in length; parotoid very large, broadly triangular in shape, its diagonal length equal to or greater than length of head; heel to middle of parotoid. Widespread . . . . . *marinus*
   Smaller toads (probably less than 100 mm.); parotoids smaller, less than area of the supraocular cover 8
8. Heel fails to reach the parotoid; tympanum diameter in eye length approximately 2.2 times; parotoid oval, rounded or biscuit-

shaped, diagonally placed; equal to or slightly longer than the supraocular cover; head crests rather low; 70 mm.; San José, "Arriba," Cartago, Costa Rica ..... *coccifer*

Heel reaches to tympanum or eye; parotoid distinctly smaller and shorter than supraocular cover; head crest more elevated; tympanum one half of eye 9

9. A dorsolateral row of large sharp conical tubercles (10-12) from parotoid to near groin; toes half webbed; a flat surface between nostrils; sides of neck, legs and arms with strong conical spines; large (100 mm.); widespread; El General, C. R.; Central America to Ecuador ..... *coniferus*

Dorsolateral spiny tubercles not strongly pronounced 10

10. Toes nearly free; eastern central Costa Rica ..... *melanochloris*

Toes half webbed; Cartago, C. R. ..... *leutkenii*

Bufo haematiticus Cope

Figure 1

Bufo haematiticus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, pp. 157-158 (type locality "Region of the Truando, New Granada"); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 101 (Sipurio, Costa Rica) and p. 155 ("Camp Mary Caretta, Panamá"); Günther, Proc. Zool. Soc. London, 1870, p. 401; Peters, Monatsb. Akad. Wiss. Berlin, 1873, p. 618 (Chiriquí, Panamá); Boulenger, Catalogue of the Batrachia Salientia s Ecaudata in the collection of the British Museum, 2nd ed. 1882, p. 290 (Costa Rica); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 10 (Talamanca, Costa Rica; "Mary Caretta" [possibly Margarita] Panamá; Coban, Verapaz, Guatemala; Nicaragua); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1901, pp. 243-244 (localities in Nicaragua); Nieden, Das Tierreich, Lief, 46, Anura, I, 1923, pp. 110-111 (Nicaragua to Colombia); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, p. 408 (Canal Zone); Wettstein, Sitzungsb. Akad. Wiss. Wien, Math-Naturw. Kl., Abb. 1, Bd. 143, Heft. 1 and 2, 1934, p. 7.

Rhaebo haematiticus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, pp. 357-358; *idem, ibid.* 1863, p. 49.

Rhaebo haematiticus var. *lachrymans* Cope, *ibid.* 183, p. 358 (same type locality as *haematiticus*).

Bufo (*Rhaebo*) *haematiticus* Keferstein, Nachr. Ges. Göttingen, 1867, pp. 353-354, pl. 9, fig. 3, (Costa Rica).

Diagnosis: Crown of head lacking elevated crests except for a short thick ridge above tympanum; parotoids elongate, with an angular edge continuous with the supratympanic ridge anteriorly and posteriorly with a skinfold that continues diagonally to near the groin; undersurface of hands and feet smooth with small terminal enlargements; first finger longer than second; web small between toes; back with small tubercles; skin of ventral surfaces without tubercles. Tympanum distinct. Eustachian tubes with openings.

Description of species: K.U.M.N.H. No. 24767 ♀. Head width at tympanum (22 mm.) a little greater than its length (21 mm.); canthus rostralis with angular edge; nostrils lateral, area about them slightly swollen; loreal region subvertical, slightly concave; canthal

ridge continuous with the ridge on eyelid; supraorbital edge elevated, the area between, concave; distance between the summit of the elevations (9 mm.) much greater than width of eyelid; tympanum distinct, irregularly oval (5 mm. high x 3.4 mm. long); length of eye (8 mm.) and length of snout (8 mm.) equal; parotoid large, its greatest length 15-16 mm., its dorsal width 6 mm., its greatest lateral elevation 5 mm.; lateral edge of parotoid sharp, continuous

FIG. 1. *Bufo haematiticus* Cope. K.U.M.N.H. No. 24762; Turrialba, Costa Rica; actual snout-to-vent length, 68 mm.

with a skin fold that reaches to near groin; no vomerine teeth; choanae equally (or nearly) as large as openings of the Eustachian tubes, oval in shape and somewhat lateral in position; tongue elongate, narrowed anteriorly and posteriorly, not or but slightly emarginate posteriorly; (male with a vocal sac, the single vocal slit sinistral and rather far back in mouth); palate strongly corrugated posteriorly.

Arm long; fingers elongate, the first longer than second and likewise larger and equally as long as third; large subarticular tubercles; supernumerary tubercles on palm present but indistinct; outer palmar pad large, circular, inner large, prominent at base of first finger; (no sexual modification of the first finger discernible in male); arm, drawn backward, fails to reach end of body (in male extends a little beyond body); a row of indistinct tubercles under forearm; small pads under terminal phalanges very slightly wider than adjoining part of digit; legs moderately long, the toes short, with thickened terminal pads slightly wider than adjoining part of digits; a strong inner metatarsal tubercle, and a small rounded outer tubercle; subarticular tubercles distinct, but little elevated; a web remnant between toes with a lateral ridge or fringe on digits extending to terminal pad; no tubercles on sole; a tarsal fold extending half length of tarsus; heel reaches to middle of orbit; when femora are placed at right angles to body the heels barely touch.

Skin tubercular on dorsal surfaces, nearly without tubercles on under surfaces; granular about vent and under mesial portions of femora; slightly granular on posterior part of abdomen.

Color: Brownish or blackish brown on dorsum with a few light tan flecks on shoulders, rather more grayish on sides; venter dusky, more or less clouded or flecked with darker; underside of femur mottled dark and light; underside of feet and hands slate; under surface of tibia blackish with distinct purple spots on anterior and posterior faces; purple spots on foot and on anterior face of femur; side of head, neck and body with a purplish stripe, bordered above by the diagonal lateral skin fold of light lavender.

Measurements in mm.: Nos. 24767 ♀ and 24761 ♂; snout to vent, 73, 54; length of snout, 8, 6; length of eye, 8, 6.1; height of tympanum, 5, 3.4; length of tympanum, 3.4, 2.2; length of parotoid, 15-16. 15; arm, 44.6, 34; hand, 17, 13; leg, from vent, 95, 74; tibia, 30, 25; foot and tarsus, 38, 33.

Variation: In some of the specimens there is marked difference in coloration, some being nearly uniform black while others are light purplish above with paired discrete black spots or scattered small spots and flecks. Some are uniform light brown above. Certain other specimens are blackish or brownish above with yellowish tan or reddish marks distributed as follows: a diagonally-placed pair of spots between orbits; a transverse pair just behind orbits narrowly separated; a pair of regular spots on shoulder, a single median spot on middle of back; a pair on the rump and two small irregular spots

behind these; a small black-edged cream spot on lores in front of. and partially below, eye.

The recently transformed young were present in the bed of the Río Reventazón in considerable numbers, where tiny pools of water were to be found in rough masses of rock, some feet above the present level of the river water. It was presumed that the eggs had developed there.

Specimens were taken in the town of Turrialba and on the farm of the Inter-American Institute of Agriculture near Turrialba; at Los Diamantes, and Río Segundo, localities representing drainage both to the Caribbean Sea and the Pacific Ocean.

Bufo marinus marinus (Linnaeus)

Rana marinus Linnaeus, Systema Naturae, 1758, ed. 10, p. 211 (From Seba, Thesaurus, 1734).
Bufo marinus Schneider, Historiae amphibiarum naturalis et literariae, 1799, fasc. 1, pp. 219-222; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 138-139 (good bibliography).
Bufo agua Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 101 (Eastern Coast of Costa Rica; "especially abundant about houses"). (The very extensive synonymy of this widespread form is not here included. Nieden, *loc. cit.*, has the most complete listing of the other literature.)

Diagnosis: Enormous toads having a broad triangular-shaped body, with very large somewhat triangular parotoid glands reaching low on sides of head; head bearing all parts of the cranial crests, the parietal, perhaps, being least developed; parotoids usually reddish or russet brown in color; metatarsal tubercles very small proportionally; first finger longer than second. Males usually more rugose and smaller than females.

Description of species: (K.U.M.N.H. No. 28245, Turrialba). Head broader than long, of somewhat triangular shape; canthal crests begin close to each other between nostrils and are continuous with the curving supraocular crests, but slightly angulate at a point in front of orbit where the preorbital crest branches and continues down and slightly backward to a point below orbit; supraorbital crest curves behind eye to edge of head where it is in contact with a short supratympanic crest, and continues down behind eye as a postorbital; a pair of low parietal crests are given off from the supraorbitals; below eye there is indication of a suborbital crest (or a continuous row of tubercles) from end of preorbital crest back to below tympanum; length of eye orbit (17 mm. measured inside crests) much greater than snout length (13 mm.); nostrils closer to eye than to median anterior point on lip; tympanum small, nearly a third higher than long, its greatest diameter (7 mm.) slightly less

than half length of orbit; choanae moderate, transversely oval; tongue longer than wide, free for more than one third of its length, narrowly free on both sides; (males with paired vocal slits).

Skin of head everywhere ossified; parotoids enormous, swollen, the greatest (diagonal) length 45 mm.; greatest width 32 mm.; parotoid in contact with tympanum and supratympanic crest, and separated from its fellow by a distance of 27 mm.; interorbital region somewhat rugose; skin generally smooth with larger and smaller warts and tubercles, of which two somewhat irregular series are found on each side of the median line.

Arms and legs bearing warts and tubercles, the summits of which are covered with horn; venter and chin more or less covered with small, nearly uniform, granular tubercles, smaller and less distinct under thighs; concealed surfaces of limbs nearly smooth; upper eyelids with small warts.

Arm short, the first finger distinctly longer than the second; a small inner metacarpal tubercle at base of the first finger, a large rounded outer (median) palmar tubercle; subarticular tubercles single, small, horny; palm covered with small tubercles; leg short, the heel reaching only to middle of parotoid; a distinct, horny, tarsal fold half length of tarsus; toes about half webbed, the subarticular tubercles small, while sole and tarsus covered with smaller tubercles; inner metatarsal tubercle small, oval, outer nearly as large, but less elevated; several segregated tubercles between the two, make an indistinct horny pad.

Color: Generally reddish brown on dorsum, gradually changing to grayish brown and gray posteriorly and on hind limbs; parotoids nearly red with black on their anterior dorsal surface; some indefinite blackish brown spotting on area between parotoids; below dirty cream mottled or clouded with dusky.

Measurements in mm.: Snout to vent, 143; width of head, 52; length of head, 38; height of head (to top of crest), 24; arm, 75; hand, 31; leg, 155; tibia, 52; foot and tarsus, 81.

Variation: Males are somewhat more rugose with a smoother venter, somewhat smaller parotoids, and somewhat stronger parietal crests. Each wart and tubercle of the dorsal surface has numerous horny spinules, giving the dorsum an extremely roughened surface, the larger tubercles bearing 8 to 10 spinules. Young specimens have low crests but usually can be distinguished from other toads by the large parotoids. The call is a low-pitched, sustained trill, and is suggestive of a trilled low note of a marimba.

The species probably occurs everywhere throughout the lowland areas. It was common at Turrialba, and many large specimens were seen in the town. It is somewhat domestic and is encountered most frequently in areas about human habitations. At Cartago it was found less frequently. The most surprising locality where it was found was a small open meadow pond at an elevation of nearly 7000 feet on Volcán Poás (western slope). The specimen is a very large female.

Rana pipiens and *Rana vibicaria* were also taken in the same pond.

Specimens were also taken at Bataan (eastern lowlands), at Moravia; and heard, but not taken, at Los Diamantes near Guápiles. They appeared to be equally common throughout the summer. One large breeding chorus was encountered at Bataan on July 22, 1951.

Bufo fastidiosus (Cope)

Cranopsis fastidiosus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 96-97, pl. 23, fig. 1 (type locality, 2500 ft. elevation on slope of Pico Blanco, district of Uren, C. R., Wm. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 11 ("district of Talamanca").

Bufo fastidiosus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 326; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, pp. 83-84 (data from Cope); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 135-136.

Nannophryne fastidiosa Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, p. 257 (data from Cope).

This toad was not found in our Costa Rican collecting. I have examined, however, the two specimens in the U. S. National Museum (Nos. 32584 and 32587 from Costa Rica).

Diagnosis: A medium-sized toad, snout to vent, 58 mm. Skin of head entirely co-ossified with cranial bones; head crests strong, the supratympanic crest obtusely thickened, extending to the parotoid gland, and produced downward behind orbit as a rugose bony plate in the tympanic area; no tarsal fold or tubercles; no openings to Eustachian tubes; no tympanum; no vocal sac or slits.

Description of species: (From a cotype). Head wide, not depressed: cranial ridges including an elevated canthal ridge, a supraorbital, a postorbital and a supratympanic crest, extending back to parotoid gland; supratympanic crest thickened and produced downward behind orbit as a rugose plate to a point opposite inferior border of eye pupil; a rough concave margin bounding area usually occupied by tympanum; canthal ridges short with a groove between them; loreal and labial regions rugose with small tubercles. In profile, muzzle descends abruptly to lip and the snout tip does

not overhang the lip; posterior outline of cranial ossification squarely truncate in adults.

Parotoids short subtriangular, sublateral, as deep as long; upper surfaces on limbs and body studded with round warts, so closely approximated on limbs as to "resemble a pustular disease"; row of larger tubercles from parotoid to axilla; below numerous smaller tubercles; fingers short, free; palmar tubercles very obtuse; no tarsal folds or tubercles; tubercles on soles obscure; toes half webbed; end of longest toe reaches muzzle when extended; longest finger reaches vent.

Color: Yellowish brown above, dirty brown below; a black band extends from parotoid to axilla, or may be extended on side of abdomen, the color not affecting the light color of the tips of spines and tubercles; throat with a black spot; top of head yellow or brownish yellow.

Measurements in mm.: Snout to vent, 58; snout to orbit, 5; snout to posterior part of cranium (head length), 16; arm, 35; hand, 13; leg, 60; foot, 35.

Remarks: The tubercles on the back are not arranged in a median paired series; the lateral series of tubercles tend to diminish posteriorly. The anal flap is elongated tending to form a tube, opening at lower level of thigh, while behind the opening two ridges are indicated, separated by a groove. There are nuptial spines on two fingers in the male. The venter and chin are regularly granular, while under the thighs the granules are unequally distributed. The parotoids abut on the supratympanic ridge. The tongue is free for most of its length. Vocal sacs are wanting in males, perhaps concomitant with the loss of the tympanum.

I believe the species has not been rediscovered since the types were taken. Since the elevation of the type locality is relatively low (2500 ft. on Pico Blanco), one might expect the distribution to be extensive and not limited by the mountain Pico Blanco. The relationship of this form is with *Bufo bocourti* and *Bufo simus*.

Bufo epioticus (Cope)

Figure 2

Crepidius epioticus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875), pp. 97-98, pl. 23, fig. 2 (type locality, 5000 ft. elevation, Pico Blanco, Costa Rica); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 95; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 11 (Salamanca, [= ? Talamanca Mountain Range] Costa Rica.

Bufo epioticus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., pp. 326-327; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 135.

Nannophryne epiotica Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, p. 257.

Diagnosis: A small toad (35 mm.) lacking a tympanum, and lacking openings into the Eustachian tube (ostia pharyngea); a parotoid gland present; digits of feet webbed leaving longest median toe projecting; skin on head not ossified; inner digit of both feet rudimental. Tympanum absent.

Description of species: (From Cope.) Head a little narrower than body; cranial crests consisting of a canthal and supraorbital crest, forming a straight line from nostrils to supratympanic region, thickened opposite front of orbit, and a distinct supratympanic crest; superciliary ridges send inward; a short tuberosity at the

FIG. 2. *Bufo epioticus* (Cope). Copied from Cope, Jour. Acad. Nat. Sci. Philadelphia, 2nd ser., vol. 8, pl. 23, fig. 2 (*Crepidius epioticus*); 5000 ft. elev. Pico Blanco, Costa Rica; head-body length, 35 mm.

posterior third of orbit. Supratympanic crest short, very protuberant giving the cranium an angular outline; a low narrow postorbital ridge; no trace of tympanum; parietal region with several small osseus nodules on each side; parotoid very small, subcircular; skin everywhere rugose with minute tubercles which are sparse on dorsal, dense on ventral regions; soles smooth, no tarsal, carpal or soler tubercles or folds; longest digit extends for the length of 2.5 phalanges beyond the "flat mass" which includes the other digits; femur half enclosed in inguinal integument; a concave dermal fold from end of each sacral diapophyses to parotoid gland, which is easily obscured.

Color: Generally black; dorsum a little lighter with a few darker spots on each side; soles and palm yellowish; scapular region brown; sometimes a median dorsal band.

Measurements in mm.: Snout to vent, 35; length to orbit, 4; length to jaw angle, 11; length to axilla, 17; length to groin, 30; arm, 19; hand, 7; leg (free portion), 30; hind foot, 18.

Remarks: This species is from an elevation of 5000 ft. on Pico Blanco. One may presume that its distribution is limited to the Talamanca Range.

I was unable to find the type of *Bufo epioticus* at the U. S. National Museum and suspect that it is lost. To my knowledge the species has not been rediscovered, and is still known only from the type specimen.

Bufo coerulescens (Cope)

Ollotis coerulescens Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 98-99, pl. 23, fig. 3, 3a (type locality 3000 to 5000 ft. on Pico Blanco, Costa Rica, Wm. Gabb, coll.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the British Museum, 2nd ed., 1882, p. 281.

Bufo caerulescens Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 83 (data from Cope); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 135 (data from Cope).

Nannophryne coerulescens Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, pp. 257-259 (data from Cope.)

Diagnosis: Very small toads, 25 mm. snout to vent; most cranial ridges and tympanum absent, and there are no openings to the Eustachian tubes; skin of top of head not co-ossified with the skull bones; all digits without webs; blackish, with brown tubercles on upper surfaces; below, black, thickly marked by light blue spots.

Description of species: (The following data are from the type description.) No prominent cranial ridges except a protuberant supratympanic; the supraciliary ridge slightly elevated, continued behind in straight lines by two angles of parietal bone; no trace of a tympanum; canthus rostralis straight, angular, the lores elevated; nostrils nearer to each other than each is to orbit; tongue large elongate; skin of back and sides studded with numerous spaced tubercles, the lower surfaces nearly smooth; no tarsal fold; tubercles of palm and sole obsolete; digits distinct, those of the foot half webbed. The wrist of arm, and end of second toe of hind limb when extended forward, reach end of muzzle.

Color: Upper surfaces blackish, the tubercles brown; below black, thickly marked with light blue spots.

Measurements in mm.: Snout to vent, 25; width of head, 8; snout to orbit, 3; snout to axilla, 10; snout to groin, 21; arm, 14; hand, 5; leg, 23; foot, 13.

Remarks: This small species, approximately one inch long, may or may not be an adult animal. The type description was taken from

the largest of the cotypes and Cope comments that there is no evidence of immaturity. The specimens were taken between 3000 and 5000 ft. on Pico Blanco. This species has not been found again since the types were collected.

Bufo holdridgei sp. nov.

Figure 3

Type: K.U.M.N.H. No. 30885, collected at an elevation of approximately 7500 ft. on Volcán Barba, western slope, July 15, 1951, by Edward H. Taylor.

Diagnosis: A small toad with very short hind legs, the heel reaching to shoulder; fingers with a web remnant (about $\frac{1}{5}$ webbed); first finger longer than second; cranial ridges except supratympanic

FIG. 3. *Bufo holdridgei* sp. nov. Type. K.U.M.N.H. No. 30885; 7500 ft. Volcán Barba, western slope, Costa Rica; actual snout-to-vent length, 28 mm.

indistinct or obsolete; canthus marked, nostril nearer eye than median point on upper lip; a few conical or papillate tubercles on back and sides; no vocal sacs, no ostia pharyngea (openings of the Eustachian tubes); black above with a discrete cream line from parotoid to groin and an indication of a median, discontinuous, lighter line; venter marbled black and flesh-white; venter with rounded granules; anal opening at ventral level of thighs.

Description of type: A small specimen (28 mm.) perhaps young; the skin more or less co-ossified with skull bones; head rather flat, sloping down slightly from occiput with a slight but distinct depression between the somewhat angular canthi; areas about nostrils swollen; a vertical median ridge runs down abruptly to the median notch in upper lip, becoming slightly bifid, projecting slightly beyond lower lip; loreal region high, not or scarcely concave, sloping abruptly to lip; eye large, its length (3.5 mm.) a little greater than median snout length; a slight indication of a supraocular ridge curving about orbit with an indication of a parietal branch; a rather wide bony supraorbital ridge joining posteriorly with the small parotoid, the limit of ridge and gland indistinguishable where they join; a distinct postorbital ridge which has a short branch curving posteriorly at lower eye level; tympanum absent; parotoid on right side approximately 2 mm. long, and 2.5 mm. wide (2.8 mm. x 2.5 mm. on left side); width of an eyelid, 2.5 mm.; narrowest interorbital width, 3 mm.

Palate high, the choanae small, the greatest length of one in distance between them three times; openings of palatal glands two, situated between middle of choanae; no vomerine teeth; tongue elongate, free for half its length; no vocal slits (sex ?); no ostia pharyngea.

Arms relatively long; half or nearly half of forearm reaches beyond the tip of snout; when limbs are adpressed elbow and knee fail to touch; toes one-fifth or less webbed; first finger longer than second but shorter than third; inner metacarpal tubercle present and a large single palmar tubercle; subarticular tubercles flat, somewhat indistinct as are the supernumerary tubercles on palm; longest finger reaches beyond vent.

Leg relatively short, the heel reaching the shoulder; toes approximately one-third webbed; subarticular tubercles and supernumerary tubercles flat, indistinct; inner metatarsal tubercle distinct, outer smaller, but distinct, somewhat elevated (right leg amputated just below knee); no inner or outer tarsal folds or rows of tarsal tubercles.

Skin with papillate pustules scattered on back and sides; between larger pustules are smaller tubercles, and still finer minute granules or spines (evident under lens as a minute black peppering over white dorsolateral line); a rather prominent mental gland; vent carried to lower level of thigh, somewhat elevated about opening; skin of venter somewhat granular; arms and legs with rough tubercles.

Color: Generally black or blackish brown above with discrete dorsolateral white lines from supratympanic crests to groin; a discontinuous median line not especially distinct; black of sides extending to level of venter; venter white; marbled with brownish black; under side of limbs similarly colored; chin largely white; hands and feet barred with dark and light.

Measurements in mm.: Snout to vent, 28; width of head, 11.6; length of head, 10; length of eye, 3.5; length of snout, 3.35; elevation of head at parotoid, 6; arm, 19.8; leg, 34; tibia, 9; foot and tarsus, 16.2.

Remarks: It is presumed that this species is related to *Bufo fastidiosus* since both seemingly lack the ostia pharyngea and the tympanum throughout life. From *fastidiosus* it differs in that the bony process covering the tympanic area is absent, and the dorsolateral white stripes are present. Ventral and dorsal coloration is different. Crests are probably never developed as in *fastidiosus*. There is no distinct row of tubercles from tympanic area to groin; toes are less than half webbed; top of head black, not yellow. The numerous large warts and tubercles on the sides are absent.

While it is not easy to make a comparison of two specimens differing so much in size as this and the types of *fastidiosus*, I have no doubt as to the distinctness of the form here described.

The species is dedicated to my good friend, Dr. Leslie Holdridge of the Costa Rican Ministry of Agriculture, my host at Río Segundo, who provided transportation for me to the collecting grounds on Poás and Barba volcanoes and collected numerous specimens which he presented to me.

Bufo coccifer Cope

Bufo coccifer Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 130 ("Arriba," Costa Rica, C. N. Riotte, coll., U.S.N.M. No. 6490); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 100-101, pl. 23, fig. 5 (the text in this description is the same as that for the preceding reference, save that the locality is omitted); U. S. Nat. Mus. Bull. No. 32, 1887, p. 11 ("Tuchitan" = Juchitán, Tehuantepec, F. Sumichrast, coll.; city of Guatemala, Van Patten, coll.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd Ed., 1882, p. 322 (Costa

Rica); Günther, Biologia Centrali-Americana, Reptilia and Batrachia, Feb. 1901, pp. 250-251 (Tehuantepec, Mexico; Guatemala City, Guatemala; vicinity of San José, Laguna de Palma, Costa Rica, Underwood, coll.); Nieden, Das Tierreich, Lief. 46, Anura I, 1923 June, pp. 76, 132 (Mexico to Costa Rica); Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 35, 41, fig. 6, a, b; Wettstein, Sitzungsb. Akad. Wiss. Wien, Math.-Naturw. Kl. Abt. 1, Bd. 143, Heft 1 and 2, 1934, p. 7 (San José, Costa Rica); Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, p. 558, pl. 22 (Agua del Obispo, Guerrero, Mexico); Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, p. 44 (Cacoprieto, Oaxaca, and other recorded localities).

Diagnosis: A medium-sized toad, snout-to-vent measurement 70 mm.; head with a complete set of rather high cranial ridges; a small parietal branch also present; a subocular ridge present; parotoids distinct, small, diagonal, somewhat circular or globular, touching the supratympanic crest; tympanum distinct; no tarsal fold, but an indistinct row of tubercles; heel to parotoid gland; first and second fingers equal; toes about half webbed.

Description of species: (K.U.M.N.H. No. 24747) Canthal crests begin above nostrils, they join the supraocular ridges at an obtuse angle; latter crests curve above eye where they branch to form a thick supratympanic crest; a short slender postocular crest sharply defined; a short but distinct parietal crest; head wide (28 mm.), considerably greater than its length (21 mm.); snout rather pointed, the canthal crests separated anteriorly by only a very narrow depression; a slight vertical ridge on the tip of the snout; eyelid, with a thick edge, its width 5.4 mm., equals width between the supraorbital ridges (5.4 mm.); area about nostril swollen, the loreal region sloping abruptly; length of eye (7 mm.) a little less than length of snout (7.5 mm.); the suborbital ridge begins at posterior edge of upper jaw, and nearly parallels it to anterior level of eye; tympanum small, its greatest diameter (vertical, 3.2 mm.) contained in eye length, 2.18 times; parotoid length, 8 mm., width, 5.8 mm., diagonally placed, in contact with tympanum and supratympanic ridge.

Choanae small; tongue elongate, the sides nearly parallel, free for more than half of its length; (males with vocal slits). Arms moderately large, the wrist reaching beyond snout; fingers free; first finger equal to, or, a little longer than second; none of the subarticular tubercles bifid; digits not tipped with horn; two large palmar tubercles.

Leg short, the heel fails to reach to parotoid; foot one fourth webbed; inner metatarsal tubercles large somewhat pointed anteriorly the outer tubercle smaller; distal subarticular tubercles of third and fourth toes bifid.

Skin of dorsal surface everywhere tubercular or slightly spinous, especially on sides of neck and body; all ventral surfaces finely granular.

Measurements in mm.: Snout to vent, 70; head width, 28; head length, 21; arm, 37; hand, 9; leg, 69; tibia, 24; tarsus and foot, 34.

Color: Above brownish black with a very indistinct lighter stripe from parotoid to groin, bordered below by a dark stripe; some dark dorsal reticulation; ventral surface dirty yellowish-white; distinct reticulation on posterior face of thighs; a very indistinct narrow median light line.

Remarks: Males are generally olive above, and all have a greenish black spot on the throat over the vocal sacs; many tubercles on feet lighter than ground color. One or two specimens have some dark spotting on breast. There is considerable variation in vocal slits. Some males have them dextral, some sinistral, some have them present on both sides. Males have the nuptial asperities present, chiefly on the first and second fingers; a small row is also present on the inner edge of the third.

All of the specimens of *Bufo coccifer* I have found in Costa Rica were taken at night in the streets of Cartago. They come out usually after heavy rains. I have not found them breeding or calling. Specimens were taken August 26-27, 1947, and on August 28 and 29, 1951. A total of 28 specimens have been examined.

Bufo coniferus Cope

Figure 4

Bufo coniferus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 159 (type locality, Turbo Region, Colombia); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 321 (data from Cope); Proc. Zool. Soc. London, 1898, p. 123; Zool. Record for 1899, Rept., p. 29; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1901, p. 251, pl. 69, fig. B (La Palma and Carillo, Costa Rica) (Figure excellent); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 133 (Mexico to Ecuador [the species is not known to occur in Mexico]).

Chilophryne conifera Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, p. 358 (listed only).

Iucilius coniferus Cope, *ibid.*, 1863, pp. 49-50 (listed only).

Bufo ehlersi Werner, Verh. zool.-bot. Ges. Wien, vol. 49, 1899, p. 481 (*fide* Günther and Nieden) (type locality, El Bergell, über Guaduas 1400 m. Colombia).

Diagnosis: A large species reaching at least 95 mm. in length; head with strongly developed crests; canthal crests terminate behind nostrils, the area between them being filled with osseus tissue leaving a plane surface between nostrils; supratympanic crest forming a thickened overhanging shelf; toes more than half webbed; parotoids

very small; tympanum large; trunk rather smooth on dorsal surface, with a dorsolateral row of large conical tubercles, 10 or 12 in number, extending from parotoid to groin.

Description of species: (From U.M.M.Z. No. 72029 ♀ "El General," Costa Rica). Head very rough, its width (33 mm.) much greater than its length (26 mm.); length of eye (7.2 mm.) less than snout length (8.3 mm.); distance between nostrils (4.2 mm.) much

FIG. 4. *Bufo coniferus* Cope. K.U.M.N.H. No. 30303; Moravia, Costa Rica; actual snout-to-vent length, 83 mm.

less than distance of nostril to eye (5.9 mm.); tympanum irregular, as high as wide (5 mm.); canthal crests more or less continuous with the supraorbital crests strongly curving to nostrils where they terminate at a level platform between the nostrils. At point where preorbital ridge descends, the crest is thickened; from this point back the supraorbital crests are parallel or nearly so; angle of supraorbital crest and the parietal crest nearly a right angle; the supratympanic crest forms a thickened beaded shelf above the tympanum; the postorbital crest is short; lower jaw with a beaded crest running

forward to anterior edge of eye. Upper lip and lower edge of lower jaw covered with dark horn as are the cranial crests; the horn often being somewhat beadlike; parotoid very small, its greatest length about 6 mm.; its width about 3.5 mm.; width of an eyelid 5.3 mm., much less than interorbital distance (13 mm. measured from outer edge of the supraorbital ridges).

The diameter of a choana (1.5 mm.) is contained in the distance between choanae (8 mm.), 5.3 times; tongue narrow, wider near the posterior end, about ⅓ free; Eustachian tubes present, the openings not larger than choanae; transverse palatine ridges not distinct.

Arm long, more than half of the forearm extending beyond the tip of the snout; fingers long, slender, not webbed, the tips more or less covered with a brown horny material; proximal subarticular tubercles distinct; distal tubercles on outer fingers dim, scarcely separable from the flat, smooth, pavementlike granules under toes; palms smooth, with flat granules; a small inner metacarpal tubercle; a large subcircular outer palmar tubercle; leg rather long, heel to beyond tympanum; toes more than half webbed; outer metatarsal tubercle small (half length of toe), outer scarcely discernible; subarticular tubercle moderately distinct, flat; no tarsal fold or continuous row of tubercles.

The middle part of back relatively smooth, the few tubercles low, rounding, indistinct; interorbital region quite smooth; side of head with many fine tubercles, those back of jaw angle rather enlarged; a row of 10-12 large conical tubercles along side from parotoid to some distance from groin; upper surface of arms and legs with conical tubercles; chin, belly and sides with minute spinous tubercles, the spines obsolescent or absent on abdomen, and under femora; ventral and posterior part of thighs with relatively low conical tubercles bearing small spines.

Color: Slaty gray on dorsal surface, with some olive-slate marking or clouding; a diagonal gray stripe running back from parotoid; arms and legs banded with the olive, separated by gray areas; surface of the cranial ridges black; horny spines arising from the tubercles, deep black-brown; ventral surfaces dirty white with lighter and darker marbling; tubercles on femora light olive with brown spines; tips of digits black-brown.

Measurements in mm.: (K.U.M.N.H. No. 72029) Snout to vent, 84; length of snout, 8.3; length of head, 26; width of head, 33; eye, 7.2; tympanum, 5; arm, 66; hand, 27; leg, 112; femur, 38; foot and tarsus, 53.

Variation: The vocal sac in the male (K.U.M.N.H. No. 72021) has a single opening. The throat is not black, and the whole body is light fawn to brownish olive. The first finger is covered above and on the sides with nuptial asperities while the second finger is partly covered nearly to tip. A low vertical ridge is present on the tip of the nose.

Remarks: This large species occurs on the Pacific as well as the Atlantic side of Costa Rica, and its range extends well into Colombia and Ecuador. Reports of this species farther to the north in Mexico are very probably based on specimens of another species.

In 1951 I collected this species at Bataan and Moravia, Costa Rica. In life the general appearance of the two males taken at Bataan differed somewhat from the three males taken at Moravia; however the differences probably may be attributed to age differences, the Bataan specimens being smaller. All of the males lack the strong markings of the type. However two females, a large and a small specimen, do agree better with the typical markings. The larger, (K.U.M.N.H. No. 30303) measuring 83 mm. from snout to vent, was (in life) a brilliant leaf green on head, dorsum and sides of body, while on the ventral surfaces the color was dirty white with distinct mottling over underside of limbs, thighs and belly as far forward as a line between arm insertions. The underside of feet and tarsi are similarly marked. On the dorsal surfaces there is a black bar that passes across the head between the base of the parietal ridges, and beginning at the posterior terminations of these ridges, a deep black line diverges on to the shoulders. These lines widen, and soon terminate on the middle of the back. A pair of spots, rather narrowly separated mesially, run diagonally and terminate on the side. A pair of somewhat longitudinal spots are present somewhat in advance of the vent. The intervening surfaces between these spots are occupied by marks somewhat blackish brown but less strongly defined, the anterior being more or less connected mesially and likewise connects with a dark lateral irregular line. A pair of somewhat irregular spots are present on each side of the rump, also connecting with the lateral band. The limbs are strongly barred, the bars extending on to hand and foot. The back of the thigh is marbled with greenish, yellowish and black, and a second black band is present low on the side separated from the lateral dark mark by a yellowish green stripe following the line of enlarged conical scales.

In the young female (K.U.M.N.H. No. 30304, 43 mm.), the darker spots are well defined, and the intervening spots or blotches are

represented only by a slight clouding of darker color. In preservative the green disappeared in a few days and was replaced by grayish coloration.

The males all have single vocal slits; three are dextral, two sinistral. In none of the specimens can the supraocular crests be said to be straight. Adequate series from the type locality may show still further differences from the Costa Rican species here considered as *coniferus*.

Bufo luetkenii Boulenger

Bufo luetkenii Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 8, 1891, pp. 455-456 (type locality, Cartago, Costa Rica; A. S. Oersted, coll.); Günther, Biologia Centrali-Americana, Reptilia and Batrachia, May 1901, p. 253; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 184.

Diagnosis: A large toad, with a series of prominent crests or ridges on head; tympanum large, half as large as eye; parotoid smaller than an upper eyelid; first finger longer than second, all fingers with single subarticular tubercles.

Description of species: (From type, after Boulenger). Crown of head deeply concave, with prominent crests, a canthal, a preorbital, a supraorbital, a postorbital and an orbitotympanic (supratympanic); parietal ridges short, oblique, directed inwards; snout rounded, not prominent; interorbital space at least as broad as the upper eyelid. Tympanum very distinct, two thirds or three fifths of eye diameter; first finger considerably longer than second; toes half webbed with single subarticular tubercles; two small metatarsal tubercles; no tarsal fold. The tarso-metatarsal articulation reaches tympanum or eye. Dorsal surface with small irregular warts; parotoids very small, oval, oblique, not much larger than tympanum.

Color: Brown above, with or without yellowish spots; dirty white below, without any spots. Male with a subgular vocal sac, and copulatory (nuptial) asperities on the three inner fingers.

Measurements in mm.: Snout-to-vent length, 82.

Günther, *loc. cit.*, has added some information concerning the type: snout short, rather compressed, with sharp, nearly straight canthus; upper parts with few very small tubercles, a lateral series of somewhat larger ones from parotoid towards groin; lower parts finely granular, a series of small spines in place of a tarsal fold; a light vertebral band.

Distance from snout to vent, 78 mm. ♀ ; vent to metatarsal joint, 65 mm.; vent to end of fourth toe, 87 mm. It is presumed that this is the specimen listed as measuring 82 mm. by Boulenger.

The species was described by Boulenger from three specimens,

one of which is in the British Museum. The species is rare in collections. In my collecting in and near Cartago, I have not found it.

Bufo melanochloris Cope

Figure 5

Bufo valliceps var. Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 100 (eastern Costa Rica).

Bufo melanochloris Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, p. 85 (type locality, eastern Costa Rica, W. W. Gabb, coll.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 320; Günther, Biologia Centrali-Americana, Reptilia and Batrachia, pp. 252-253; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 134 (Costa Rica).

Diagnosis: A medium-sized toad with a crested head; diameter of tympanum about half of eye length; first finger longer than second; finger and toes long, nearly free of web; rather small parotoid glands and a lateral dermal fold present; greenish above with deep black spots; throat and thorax black.

FIG. 5. *Bufo melanochloris* Cope. K.U.M.N.H. No. 30275; 1 mi. W Pacuare, on Pacuare River, Costa Rica; actual snout-to-vent length, 42 mm.

Description of species: (From type, U.S.N.M. No. 30592). Head with a full set of crests; canthal crests relatively low forming a slight angle with supraorbital; supraorbital crests curving slightly inward so they are a little closer together midway in interorbital region; parietal crest well developed; supratympanic crest very strong, shelflike; parotoid moderate to small, diagonally placed; loreal region somewhat concave, sloping abruptly to lip; a ridge along upper edge of bone in upper jaw below eye; area about nostrils swollen, with a slight groove between them; a flat or slightly curved broad vertical ridge on snout; tympanum somewhat circular, a little higher than wide, its diameter 2.6 mm., a little less than half length of eye; length of eye approximately equal to length of snout.

Choanae large, the width of one (1.6 mm.) in distance between them (3.6 mm.), a little more than twice; tongue long, slender, free for more than half its length; (vocal slits present in males).

Arm covered with rough tubercles, long, the wrist reaching tip of snout or a little beyond; first finger larger than other fingers; hand with smooth tubercles, some minute, others variable in size; lateral ridges on second finger; a small inner metacarpal tubercle; larger outer tubercle; distal subarticular tubercles on fingers bifid; fingers without webs.

Foot and heel broad, the tubercles under feet rounded, high, not spinose, tips of toes slightly inflated, rounded, suggesting terminal discs; first two toes, a little less than two thirds webbed; outer toes about one third webbed; inner metatarsal tubercle moderately large, with a rather sharp free edge; outer tubercle conical; distinct, high, subarticular tubercles; legs covered with spinose tubercles; a row of similar tubercles replace inner tarsal fold; lateral ridges on toes; heel reaches eye; the heels, when the legs are folded at right angles to body, overlap 3 millimeters; back with scattered low tubercles; dorsolateral row of tubercles indistinct; venter, throat and breast with granular surfaces, the granules not flattened.

Color: Back gray-olive with at least 5 pairs of irregular black spots, some more or less connected longitudinally with a dusky gray marking; a dim lighter median line; spots beginning on eyelids are more or less connected by an intercalated pair of small dusky spots; somewhat broken blackish spots present on lips; thigh and tibia with indistinct darker bars; chin and breast dark, with lighter flecks; belly brownish or brownish white; brownish under femora.

Measurements in mm. of Bufo melanochloris Cope

Museum Number	U.S.N.M. 30592	M.C.Z.[e] 7932
Snout to vent	47	57
Width of head	18	22
Length of head	17	20
Length of snout	6	7
Tympanum	? x 2.6	4 x 3.4
Length of eye	6	7.1
Interorbital width	5.5	5.8
Width between nostrils	3.3	. . .
Width of eyelid	4.2	5.5
Arm	27	33
Forearm and hand	20	.
Hand	10	14
Leg	56	59
Tibia	22	25.5
Foot and tarsus	26	29
Parotoid	....	6.5 x 3.4

Remarks: There are seven specimens in the K.U.M.N.H. collection, the largest of the lot measuring only 42 mm. They differ but little from the described specimens. Five of these were taken on the banks of the Reventazón where the highway to Moravia crosses it, and two at Pacuare on the road to Moravia. A part of these were found ensconsed in debris; others were hopping about in a slight shower. There are two specimens in the R.C.T. collection from the farm of the Inter-American Institute of Agriculture at Turrialba. The specimens are presumably all females, none showing nuptial asperities or vocal slits.

The most significant difference appears to be in the length of the third finger which is equally as long as the first, if not slightly longer.

There is a gray band between the eyes, bordered in front and behind by black; the median gray line is present in all. The median spots on forearm, thigh and tibia are much darker than other spots or bands. Much of the under surface of the thighs is yellowish white. The tympanum is separated from postorbital and supratympanic crests by a distance nearly half its diameter. The tympani, 2.3 mm. × 1.9 mm., are a little less than half of eye length (5 mm.). The greatest (diagonal) length of the parotoid gland is not greater than the length of the eye.

[e] From Orotina, Costa Rica.

Bufo gabbi nov. nom

Figure 6

Bufo auritus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1876 (1875) pp. 99-100, pl. 23, fig 4 (east coast region [= Talamanca], Costa Rica, Wm. Gabb, coll.), (nec *Bufo auritus* Raddi, 1821); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 321; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, pp. 75-76 (data from Cope); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, May 1901, p. 256; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 11; Nieden, Das Tierreich, Lief, 46, Anura I, 1923, p. 134.

This small species still remains very rare. No data are published save those taken from the type specimens. The description here is drawn from one of the syntypes.

Diagnosis: A diminutive toad (31 mm. from snout to vent) with distinct crests, but lacking a preorbital crest; parotoid small surmounted by dermal spines; digits, especially fingers, elongate; heel reaches to nose; anterior half of tympanum visible; the Eustachian tubes with very small, triangular openings; toes a little more than half webbed; auricular region a somewhat projecting shelf.

Description of species: (From a syntype, U.S.N.M. No. 30676). Head generally triangular, casquelike, the top flat, the snout a little more elevated than the interorbital area, the canthal edges having the greatest elevation, bearing short beaded ridges, and a depression or groove between them; nostrils slightly swollen on side much below the canthus; a slight terminal dermal projection and a small vertical ridge from lip; loreal region with a depression running back from the dermal tip and terminating above the maxillary at anterior level of the preorbital ridge; the junction of the preorbital, canthal and supraorbital ridges swollen or thickened and the preorbital with a somewhat diagonal position; supraorbital crests somewhat angular around eyelid but actually they appear to be continuous with the parietals, which turn abruptly mediad toward their ends at back of occiput but do not touch; the combined crests parallel for most of their length; a vertical postocular and a supratympanic crest present; skin of the interorbital area co-ossified with the skull; the somewhat circular area above supratympanic crest almost completely enclosed by the ridges; when seen from above, the auricular shelf projecting forms "ears"; the length of the head equals its width at the auricular shelf (10 mm.); the eye large, its length (4.2 mm.) greater than length of snout; entire length of the orbit measured from ridges, 4.7 mm.; the measurement of the interorbital region 5 mm.; a ridge borders upper edge of upper jaw.

Choanae large, laterally placed; no vomerine teeth; tongue flat, thin, straplike; small triangular openings to the Eustachian tubes; tympanum not distinct save on its anterior edge. The processes of the second and third vertebrae are elongate causing the neck to be wider than the head.

Arm with a strong preaxial web, the wrist reaching beyond tip of snout; fingers especially long, unwebbed; the two outer longest; first finger shorter than second; numerous tubercles cover arm, and a row on the under surface tends to form a dermal fold; subarticular tubercles very indistinct; elongate inner metacarpal tubercle; a large palmar tubercle.

Leg long, heel reaches beyond snout tip. Foot about three fourths webbed on inner toes, two thirds webbed on outer toes; subarticular

FIG. 6. *Bufo gabbi* Taylor (new name). Redrawn from Cope, (*Bufo auritus*). Journ. Acad. Nat. Sci., Phila., 2nd ser., vol. 8, 1875, plate 23, fig. 4; actual size, head and body, 31 mm.

tubercles scarcely discernible; heel broad, the inner metatarsal tubercle sharp, elevated; outer tubercle small, conical; seemingly there is an indistinct tarsal fold; toes pointed.

Skin of back somewhat tubercular, sides with spiny tubercles; under thighs and below on venter finely granular; a transverse row of four tubercles on the skin of neck; sides of neck at its widest part bordered by sharp spines; a skin fold from occiput curves around to the ends of the vertebral processes. Eyelid tubercular, the spines but little elevated; the parotoid gland very small with some spines.

Color: The color has faded so that it cannot be determined now.

The original color data states: "Color brown, a quadrate patch on vertex from orbits to occiput, an oblique band from the latter outwards on each side; and a spot on each lateral sacral region black; belly marbled with black, throat and limbs below dusky."

Measurements in mm.: (of a syntype, U.S.N.M. No. 30676). Snout to vent, 31; width of head, 10; length of head, 10; length of snout, 4; length of eye, 4.2; arm, 26 (23)*; hand, 10; leg, 43 (38); tibia, 13; foot and tarsus, 21.4 (21).

Remarks: It would appear that the name *Bufo auritus* used by Raddi ** for a Brazilian species of amphibia has been overlooked by Boulenger, Nieden and others. Since the name is preoccupied, a new name is necessary, and I propose the name of *gabbi* in honor of Wm. Gabb, its discoverer.

I am not aware that specimens other than the two cotypes are known. It has not been retaken since the discovery more than 75 years ago. One may presume that the species is confined to the Talamanca range. The type locality, so far as I know, has not been revisited by an herpetological collector since its discovery.

FAMILY BRACHYCEPHALIDAE

Representatives of two subfamilies of this family are present in Costa Rica: The Dendrobatinae with two genera of small toadlike forms, and the Brachycephalinae with one genus of somewhat larger frogs.

KEY TO THE SUBFAMILIES OF BRACHYCEPHALIDAE

Dermal scutes on dorsal surface of the digital discs .... Dendrobatinae
No dermal scutes on dorsal surface of the digital discs ... Brachycephalinae

KEY TO THE COSTA RICAN GENERA OF BRACHYCEPHALIDAE

1. A pair of dermal scutes on the upper surface of the somewhat dilated terminal digital pads; an omosternum present, either of cartilage or bone; toes without distinct webs (present in *Hyloxalus* which is not known as yet in Costa Rica) 2
   No dermal scutes on the upper surface of digital tips; no omosternum present; toes webbed the foot somewhat palamate .. *Atelopus*
2. Maxillary teeth present (except *P. truncatus, fide* Dunn) .. *Phyllobates*
   No maxillary teeth present ..... *Dendrobates*

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* The original measurement of arm and leg are somewhat less than my estimated measurements. The arm is folded and cannot be straightened without damage to the specimen. This perhaps was true also when measured by Cope.

** Raddi, Giuseppe, Continuazione della Discrizione der Rettili Brasilini. Mem. Nat. Fis. Soc. Ital. Sci. Modena, vol. 19, 1821, p. 71.

Subfamily Brachycephalinae

Only a single Costa Rican genus of this subfamily is known.

Genus ATELOPUS Duméril and Bibron

Type of genus: *Atelopus flavescens* Duméril and Bibron.

The frogs of this group are often brightly colored; the dorsal color being black, olive, yellow and red. They are usually slow moving and at least certain of them often move by walking rather than by hopping.

The confusion mentioned by previous writers as existing in the genus *Atelopus* still exists. Dunn (1931) has reported on certain forms occurring in Panamá. He lists five forms all belonging to *Atelopus varius,* and later he (Dunn, 1933) describes another subspecific form from El Valle de Anton in the northwestern corner of Panamá. Of the six forms recognized in Panamá it would appear that *Atelopus cruciger* might better be treated as a distinct species from *varius.*

The frogs of this group, as they occur in Costa Rica, have been difficult to treat, since the collections are inadequate from single localities and adequate series from adjoining countries likewise were not available. The arrangement here given must be regarded as tentative and at the same time, incomplete.

I am recognizing *Atelopus varius varius* in Costa Rica, and I here propose names for two other subspecies, *Atelopus varius loomisi* and *Atelopus varius ambulatorius.* Another form *Atelopus senex,* I describe as a new species.

Aside from these four forms, I have seen certain Costa Rican specimens in the collection at Harvard College. With further study it may well be possible to recognize other subspecific forms in material now in collections.

Two specimens examined in the Harvard, M.C.Z. collection (Nos. 16021, 16022 from the northwest slope of Mt. Carpinteria, Costa Rica, C. W. Dodge coll.) differ markedly from the forms here considered. The color characters of these are as follows:

Body above uniform dark brown on top and sides with a series of cream or yellow spots (in preservative) arranged symmetrically on the dorsum. On head a medial longitudinal mark followed by a pair of short transverse marks; on sides of shoulders a pair of elongate marks; near sacral region two diagonal marks followed by a somewhat rounded median mark; on rump two or three small spots, one on thigh, two on tibia; belly cream, the under side of

hands and feet similar to venter but somewhat more orange; a cream line on lip; a mark across arm insertion to elbow, and irregular black marks on venter. The absence of red colors may be due to fading.

No. 16023 Harvard, M.C.Z. A small form from Tres Rios, Cartago Province, C. R., has black paired spots on back; a chevronlike mark on snout and white marks over the temporal region.

No. 7943 Harvard, M.C.Z. Navarro, C. R., has finely divided black and olive-cream markings. The toes are not fully webbed (webs deeply excised). Venter strongly reticulated with brownish black; chin finely reticulated with dusky.

Adequate collecting in Costa Rica may determine whether these individuals are members of separate populations or whether they are variants of a single population.

Boulenger, in his Catalogue of the Batrachia Salientia . . ., distinguishes two Costa Rican varieties (1882, p. 153). He suggests that the second variety, "grayish above dotted with black, the light markings black-edged" are probably males, yet he lists both males and females in his variety 2.

While it is possible that there is considerable sexual difference, it seems wholly unlikely that *Atelopus varius ambulatorius* (R.C.T. No. 760, figured) could possibly be the male of either of the two females depicted herein: *Atelopus senex* (R.C.T. No. 765) or *Atelopus varius loomisi* (K.U.M.N.H. No. 24746).

KEY TO COSTA RICAN FORMS OF ATELOPUS

1. A strongly developed supratemporal ridge or boss; uniform gray-olive above, dirty whitish on ventral surfaces without markings, (38 mm.) ..... *senex*
   Temporal ridge less strongly developed; body bi- or tricolored dorsally in black, red or yellow 2
2. Venter orange-red and black, black and yellow above, no red on dorsum, larger, (44 mm.) ..... *varius loomisi*
   Not orange-red on venter, red may be present in dorsal coloration, 3
3. Dorsum black with red and yellow markings; venter yellow or cream with or without dark spots; larger, (40 mm.) .. *varius varius*
   Dorsum greenish yellow with narrow black markings; venter yellow, chin cream with or without dark marks; smaller, (33 mm.) ..... *varius ambulatorius*

Atelopus varius varius (Lichtenstein and von Martens)

Atelopus varius Stannius, *In* Handbuch der Zootomie, von Siebold und Stannius, 2 auflage, 2 buch; Zootomie der Amphibien, Ed. 2, 1856, p. 16. (*nomen nudum*); Peters, Monatsb. Akad. Wiss. Berlin, Feb. 16, 1863, p. 82. (refers the genus *Phrynidium to Atelopus* Duméril and Bibron); Keferstein, Nachtr.

k. Ges. Wiss. Göttingen, 1867, pp. 350-351 (Costa Rica, von Seebach coll.); Keferstein, Arch. für Naturg., Jahr. 34, vol. 1, 1868, p. 292, pl. 8, figs. 33, 34 (length of body 40 mm.; leg 53 mm.; Costa Rica.); Cope, Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 102. (*part.*) ("Very abundant on the Pico Blanco range, and in the lower country. The markings are vermillion on a black, or in the case of mountain specimens, a green ground. In some of the latter the red markings are few, and in others altogether wanting, leaving a uniform pea-green"); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 208-209, pl. 62, figs. A, B, C (*part.*); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 96, pl. XI.

Hylaemorphus Pluto, Fitzinger, in Schmidt, Denks, K.K. Akad. Wiss. Math.-Natur. Cl. Bd. 14, 1857 (1858), p. 255 (Costa Rica, Dr. Scherzer, coll.).

Phrynidium varium Lichtenstein and von Martens, Nomenclator Reptilium et Amphibiorum Musei Zoologici Berolinensis . . . 1856, pp. 40, 41, Berlin (Veragua, Panamá); Cope, Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, 1867, p. 196.

Phrynidium varium adspersum Lichtenstein and von Martens, Nomenclator Reptilium et Amphibiorum . . . 1856, p. 41.

Phryniscus varius Günther, Catalogue of the Batrachia Salientia in the collection of the British Museum, 1858 (Feb. 12, 1859) p. 45; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the British Mus., ed. 2, 1882, p. 152.

Atelopus varius varius Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 393-397 (upper Costa Rica; Panamá); Wettstein, Sitzungsb. Akad. Wiss. Wien, Math.-Naturw. Kl. abt. 1, Bd. 143, Heft 1 und 2, 1934, p. 7 (La Carpintera).

It is probable that some of the above synonomy is not wholly referable to *Atelopus varius varius.*

The original description in the "Nomenclator Reptilium et Amphibiorum Musei Zoologici Berolinensis" is extremely brief: *Phr. varium nob. Rostro longiusculo. Supra nigrum, flavomaculatum labiis apicibusque digitorum flavis; subtus flavum.* For one of the subspecies, which Dunn chose as the synonym of the typical form (*adspersum*), the description given is as follows: *minus, rostro paulo breviori, maculis dorsi clavatis, ellipticis, parvis, frequentibus, modo flavis modo rubris; pedibus flavomaculatis; abdomine modo unicolore flavo, modo maculis parvis raris rotundis nigris insignito. Long. corp.* [$1\frac{2}{3}$ inches?].

While the types were from Veragoa [= Veragua, Panamá] Keferstein (1867) reported the species in Costa Rica. Dunn* has reported the typical form in San José and "upper Costa Rica."

Günther (Biologia Centrali-Americana, Reptilia and Batrachia, 1900, pp. 208-209) has placed Schmidt's *Hylaemorphus dumerilii* and *Atelopus varius maculatus* Peters as a synonym of what he calls *Atelopus varius.* Under the latter name he has reported specimens from Guatemala; Costa Rica (Bebedero, Escazú, Izaru [= Irazú?], San Marcos, Tivas elev. 1000 m., Santa Clara 400 m.; Panamá (Veraguas, Chiriquí).

* Dunn (1931, p. 394), gives a reference (Stannius 1856, *Handb. Zool.* 2, p. 16), that I am unable to find.

It is perhaps significant that he does not place in synonymy *Phryniscus cruciger* [Lichtenstein and von Martens] which seemingly should be regarded as a species distinct from *varius*.

Diagnosis: A medium-sized subspecies reaching a length of approximately 40 mm.; skin smooth, snout elongate. Black above with small markings of red, pink, green or yellow; venter yellow or yellow with some black spotting.

Description of subspecies: (From Keferstein 1867 and 1868). Head short flattened, the eyes scarcely protruding; body slender, narrow; dorsum and head entirely smooth; a small web between the two inner fingers; all toes bound together with large webs, that on the inner toe reaches to the tip; on the fourth and longest toe webs reach only halfway except that a narrow fringe reaches the tip in all cases. A very small web between the two inner fingers. Sole of foot broad, smooth; no tubercles even on metatarsus except a tiny, scarcely noticeable tubercle on the outer metatarsus. A skinfold on the inner side of metatarsus. The entire dorsal surface is brownish black with reddish flecks; venter uniform bright golden yellow. Low on sides of head and on sides of the body golden yellow like venter. Sometimes the darker ground color, sometimes the dorsal flecks of red or yellow predominate. Snout to vent, 40; leg, 50. Costa Rica.

Remarks: I collected no specimens of this form and any material I have seen that may belong to the subspecies has been faded. Günther's Biologia Centrali-Americana, pl. 62, fig. A, (1900), seemingly is a good illustration of this form.

Atelopus varius loomisi [*] subsp. nov.

Figure 7

Type: K.U.M.N.H. No. 24746, Isla Bonita (American Cinchona plantation), approximately 5000 ft. elevation, eastern slope Volcán Poás, Costa Rica, Richard C. Taylor and Edward H. Taylor colls.

Paratypes: K.U.M.N.H. Nos. 24742-24745: R.C.T. Nos. 835-836; 2458: 2459 all topotypes, same collectors.

Diagnosis: Black and yellow above, with orange-red color below; snout narrow, with nearly vertical sides; no teeth of any kind in the mouth; tongue rather narrow, elongate; tympanum absent; nostril about halfway between eye and tip of snout; fingers nearly free; toes nearly fully webbed.

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[*] The subspecies is named for Mr. Richard B. Loomis who has assisted me greatly in criticising the manuscript and in reading proof.

Description of type: Head narrower than body its width (12 mm.) very slightly greater than length (11.5 mm.); canthus rostralis distinct but slightly rounding, the edges raised above the level of the snout; snout extending beyond mouth, in profile sloping sharply back and down to lip; nostril distinctly lateral, below canthus, the area surrounding nostrils much swollen leaving a depressed area in loreal region between eye and nostril; eyes prominent, the upper lid forming a shelf above eye, its edge bearing a somewhat thickened fold; above tympanic region a heavy thickened crest, terminating

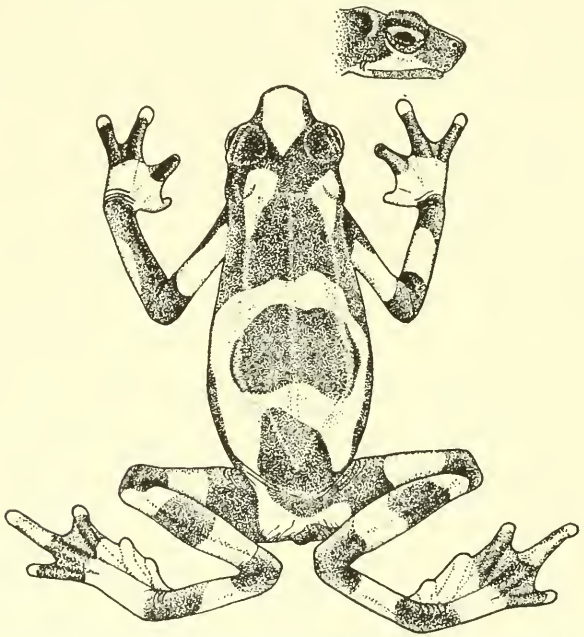

FIG. 7. *Atelopus varius loomisi* subsp. nov. K.U.M. N.H. 24744; Isla Bonita, Volcán Poás; Actual snout-to-vent length, 44 mm.

posteriorly in a somewhat elevated, rounded knob; width of an eyelid about equal to interorbital distance or a little greater; length of eye (3.5 mm.) greater than its distance from nostril (3.1 mm.), but less than snout length (4.7 mm.); tympanic area slightly depressed.

Vomerine and maxillary teeth absent; choanae lateral, concealed by maxillary shelf when examined from below; tongue narrow, elongate flaring somewhat posteriorly, unnotched; behind free for nearly half its length.

Skin smooth above and below save for some wrinkling in the

median thigh region and below vent, which opens near upper level of thigh; the very short anal flap somewhat crenulated; beginning on side of head in tympanic region series of small pearl-tipped pustules continue some distance on the sides. Ventral surface broken by longitudinal and transverse wrinkles or grooves.

Arm slender, the three outer fingers practically lacking web; however the first finger is short, scarcely more than its tip extending beyond the thickened web; second finger shorter than fourth the webbing scarcely indicated; tip of digits rounded, without discs or pads; subarticular tubercles very indistinct; an indistinct tubercle at base of first finger and an outer palmar tubercle of large area, scarcely elevated; some supernumerary tubercles indicated on palm.

Leg short, when adpressed the tibiotarsal joint fails to reach eye; foot with inner and outer metatarsal tubercles weak; subarticular and a few supernumerary tubercles faintly indicated; web includes first toe and most of second; on third the web does not reach tip on inner side; three joints of the fourth toe free but with a fringe indicated to near tip; slight suggestion of an inner tarsal ridge or tubercle near first toe.

Measurements in mm.: Snout to vent, 44; width of head, 12; length of head, 11.5; arm and hand, 32; leg, 57; tibia, 19; tarsus and foot, 30.5.

Color: Coal-black on lemon-yellow; an enclosed yellow area on top of snout; a black line follows the canthus, passes above and below eye, and continues down across tympanic area and onto arm; black mark between orbits continues back, then divides, widening on sides behind arms. A large bean-shaped mark on back placed transversely; a large black groin spot connecting across rump with one from opposite side; arms and legs with black bands, tips of digits yellow; upper lip yellow, edge of lower lip black; chin, venter and under surface of limbs orange-red; a few rounded black spots on venter.

Remarks: A series of ten female specimens are at hand. These agree remarkably well save for the details of the design on the dorsum. The measurements of the series is uniform, varying from 41-44 mm. snout-to-vent length. All contain large ovarian eggs without pigment.

It is not impossible that the Costa Rican specimen figured as *Atelopus varius* Stannius by Brocchi (Miss. Sci. au Mexique . . . part 3, sec. 2, livr. 2, 1882, p. 96, plate 11, figs. 1, 1a-1d) belongs with this subspecies.

Atelopus varius ambulatorius subsp. nov.

Figure 8

Type: R.C.T. No. 766, Isla Bonita (American Cinchona Plantation) southeastern slope Volcán Poás, elevation approximately 6000 ft. Richard C. Taylor, coll. 1947.

Diagnosis: A rather small form, related to, but differing from *Atelopus varius varius* in having a ground color dorsally greenish yellow, ventrally cream-white on chin and throat, but becoming dull yellow on venter and concealed part of limbs, and lacking any trace of the red or orange-red coloration. On back a more or less

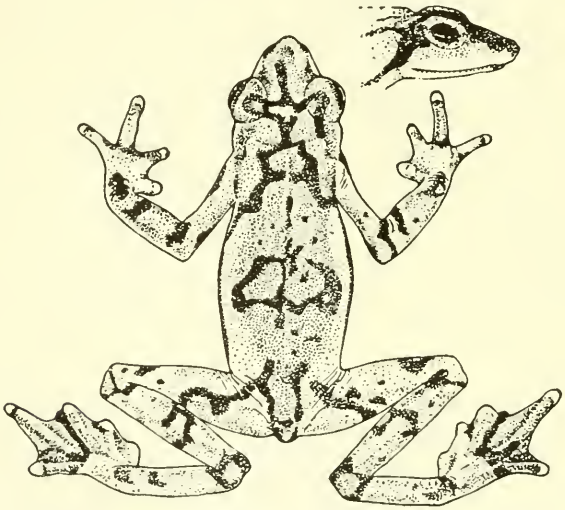

FIG. 8. *Atelopus varius ambulatorius* subsp. nov. Type R.C.T. 766; Isla Bonita, Volcán Poás: Actual snout-to-vent length, 33 mm. adult male.

symmetrical pattern of black with a black diagonal line on side from groin to eye; few very small dots of black on venter; no tympanum, the supratympanic ridge not elevated; fingers nearly free, toes fully webbed; no teeth.

Description of type: (From R.C.T. No. 766, Isla Bonita, C. R.). Probably a small species, the known snout-to-vent measurement, 33 mm.; head width (9.2 mm.) approximately equal to head length (9.4 mm.) canthus distinct, the loreal region strongly concave, the upper part of lores vertical, the lower sloping obliquely to lip; no visible tympanum; a low supratemporal ridge slightly evident; eye projecting; the eyelid bearing a thickened ridge near its outer edge

forming a strong projection, beyond the canthus or temporal ridge line; length of eye (3.5 mm.) approximately as long as snout (3.6 mm.); width of an eyelid (2.9 mm.) slightly less than interorbital interval (3.2 mm.) (one eye is lost from some earlier accident, and the lid tightly closed over the cavity); area about nostrils swollen somewhat, the width of snout at nostrils greater than width immediately behind them; a distinct broad depression on the snout; in profile snout pointed, then sloping back and down to lip, extending forward beyond lip a little more than 1 mm.

Choanae small, lateral, widely separated; palatal glands open into two pits between hind level of choanae; a pair of white (glandular?) areas between and largely behind hind level of choanae; membranes of upper roof of mouth posteriorly cut into contiguous variform tracts; ostia pharyngea minute, less than a fourth size of the small choanae; tongue small, slender, wider behind than in front, free for half its length; vocal slits long, rather posterior in position.

Arms long, the major part of forearm extending beyond the tip of snout; first finger short, thick, broader than other digits, much shorter than second; a web between the two inner fingers reaches to the small subterminal pad or disc; between second and third fingers less than a third webbed; between outer fingers only a small vestige of web evident; the webs much thickened, seemingly forming a part of the palm; pads or discs under finger tips not wider than digits; latter have no lateral ridges or terminal grooves; inner metacarpal tubercle large; low palmar tubercle equally as large but rounding; first finger with a large nuptial swelling with minute asperities covering entire upper surface of the digit; subarticular tubercles distinct, rather flat.

Leg short the heel reaching to back edge of eye; heels barely touch when legs are folded; toes fully webbed with some emargination, the web fringe reaching tip of even the fourth toe; the webs all thickened forming part of sole; inner metatarsal tubercle large, flat, indistinct; outer smaller, rounded, perhaps more elevated; subarticular tubercles small, indistinct.

Skin above nearly smooth, but under a strong lens a few minute pearly spinules are visible in the temporal region and in front of arm where there is also a slight tuberculation; skin of venter longitudinally and transversely wrinkled or grooved, breaking the surface into a pavement of small angular areas suggesting granules; under surface of thigh more or less distinctly granular; vent high, protruding, surrounded by narrow, closely-juxtaposed, fingerlike crenulation.

Color: In life greenish yellow above with series of black narrow lines forming a somewhat symmetrical pattern; sides dull yellowish with a black diagonal streak from eye to groin where it terminates by forming a sharp angle and turns diagonally forward; chin cream-white; venter and light areas of limbs dull yellow, with a few scattered tiny black dots on throat, some on sides and a few on venter; a pair of median black marks on ventral surface of thighs; underside of foot with toes black and a transverse dark mark across front of sole; three outer fingers black below; dark marks across arm and leg (see figure). A dark canthal line passing around tip of snout. A black mark from behind eye onto foreleg.

Measurements in mm.: Snout to vent, 33; width of head, 9.2; length of head 9.4; length of eye, 3.5; length of snout, 3.6; arm, 22; hand, 8.5; leg, 43; tibia, 14.5; foot and tarsus, 20.

Remarks: This subspecies was discovered at night perched on a large leaf of a plant growing in the forest near a small stream. In the same general region, but at a considerably lower elevation, I took another, presumably much larger form, *Atelopus varius loomisi,* and at a still higher elevation, across the divide a few miles westward is the type locality of *Atelopus senex.* Because of the lack of female specimens and the absence of striking structural characters, I feel it wiser to regard this as a subspecies rather than as a distinct species.

Atelopus senex sp. nov.

Figure 9

Type: R.C.T. No. 766; near pass between Volcán Poás and Volcán Barba, western slope Volcán Poás, Pacific drainage, elev. app. 6800 ft.

Diagnosis: A medium-small species of the genus, lacking all spots or specific markings; snout narrowed, the tip with a rounded point distinctly projecting beyond lip; a depression on snout between canthi; suprascapulae form prominent ridges on shoulders; thickened web at base of fingers; toes nearly fully webbed; a distinct bony temporal ridge from eye, and a distinct postorbital ridge branching from it; heel reaches only to postorbital ridge; numerous conical tubercles in groin, scattered on sides of body and neck, and on the front face of upper arm.

Description of type: Body slender its length 38 mm., the skin rather tightly drawn around body leaving the sacrum definitely outlined and the vertebral ridge in evidence. Head rather angular, the canthus well defined, the canthal edges somewhat elevated with

a depression between them extending from frontal region to near tip; the loreal region nearly vertical, but with a concave depression in front of eye, and a depression and groove below the somewhat swollen nostril, the depression tending to continue around tip of snout; a strong medial notch in upper lip; nostril a little closer to tip of snout than to eye, but nearly equidistant from eye and from the median notch in upper lip; no trace of tympanum; length of eye (3.3 mm.) slightly longer than distance between eye and nostril, much shorter than length of snout (4.5 mm.); temporal ridge marks

FIG. 9. *Atelopus senex* sp. nov. Type. R.C.T. No. 766; near the divide between Volcán Poás and Volcán Barba; snout-to-vent length, 38 mm.

widest part of head (10 mm.) the width less than head length (12.1); width of eyelid (3 mm.) less than interorbital interval (4 mm.).

Choanae vertically oval, lateral; no vomerine teeth; palatal glands open in a deep pit midway between choanae; maxillary teeth absent; tongue very small, narrow, free for half its length; ostia pharyngea minute, one eighth or one tenth size of choanae. Membranes of roof of mouth back of orbits with strong verniculate grooves; two small white glandular (?) areas between and slightly posterior to choanae.

Arms slender, long, more than half of forearm extending beyond tip of snout; digits of hand with small terminal pads, or discs, not

or scarcely wider than digits; subarticular tubercles large, flat, ill defined; webbing greatest between first two fingers (from disc to subarticular tubercle of second); scarcely more than a vestige between the outer three fingers, in all cases the web is thickened, seemingly forming a part of the palm; inner metacarpal tubercle large, poorly defined; palmar tubercle large, better defined; (right hand deformed, one digit entirely missing); conical tubercles on front face of upper arm, and on neck preceding arm insertion.

Leg short, the heel barely reaching the supratemporal ridge; when legs are folded the heels fail to touch by a distance of three mm.; toes fully webbed, with small subterminal discs, the tips not wider than the digits; subarticular tubercles ill defined; a flat ill-defined inner metatarsal tubercle; a smaller more distinct outer; subarticular tubercles weak.

Skin rather smooth with scattered small tubercles on sides of body, stronger in groin and on neck; venter not typically granular but skin wrinkled longitudinally and to a lesser extent transversely; a few granules on the chin, none or only very indefinite granules on under side of thigh; vent opening near upper level of thigh.

Color: In life, olive above, head dull greenish yellow; lips lighter, more yellowish; groin, chin and venter dull yellow. In preservation color dull brownish gray above, lighter on elbow and heel, and on the supratemporal ridges and in the frontal area; the skull is semi-transparent and the brain can be discerned as two yellowish spots.

Measurements in mm.: Snout to vent, 38; width of head, 10; length of head, 12.1; depth of head, 6; length of eye, 3.3; width of sacrum, 12; arm, 26; hand, 11; leg, 45; tibia, 14; foot and tarsus, 24.

Remarks: The specimen, collected by Richard Taylor, was found walking slowly near a small rivulet late in the afternoon. The prominence of the suprascapulae, the slightly overhanging supratemporal ridges, the widened sacrum with the slight depression of the dorsum give the animal a strange appearance. The figure given shows most of these characters rather faithfully.

The habit of walking rather than hopping has been observed in certain other species of the genus.

Subfamily Dendrobatinae

Two genera, *Phyllobates* and *Dendrobates* belonging to the Dendrobatinae occur in Costa Rica, and it is not improbable that a representative of *Hyloxalus* will eventually be discovered in the country.

Genus DENDROBATES Wagler

Dendrobates Wagler, Natürliches System der Amphibien, 1830, p. 202. Type of genus: *Dendrobates tictorius* (Schneider).

These small Costa Rican frogs of the genus *Dendrobates* may be distinguished from the species of *Phyllobates* in Costa Rica by the absence of teeth in the maxillary and in life by the very striking coloration involving black and brilliant greens, reds and blues.

KEY TO COSTA RICAN SPECIES OF DENDROBATES

Small toadlike species, 20-22 mm. snout-vent length; body vivid red, limbs blue in life; all black in preservation or rarely speckled with black on a somewhat lighter ground color. Eastern lowlands of Costa Rica ..... *typographus*

Larger, 29 mm., dorsal as well as ventral parts of body and limbs golden green and black in life; in preservative the green is replaced by blackish gray or silver ..... *auratus*

The coloration of these small forms makes them very conspicuous where they occur. They are especially active, and in places where I found them, they were very adept in escaping capture. The vivid colors disappear in a few hours when they are placed in a preserving fluid and there is left small evidence of the former brilliant coloration.

Dendrobates typographus Keferstein

Dendrobates typographus Keferstein, Nachtr. könig. Gesell. Wiss. und der Georg-Augusts Univ., Göttingen, 1867, p. 360 (type locality, Costa Rica, von Seebach coll.); Arch für Naturg., 34 Jahr, vol. 1, 1868, p. 298, pl. 9, fig. 7 (same data as preceding article); Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 102 (places *D. ignitus* in synonymy of this species); U. S. Nat. Mus. Bull. 32, 1887, p. 19, Nicaragua, Moser and Bransford colls.; E Costa Rica, Gabb coll.).

Dendrobates ignitus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, pp. 68, 69 (type locality Nicaragua; F. Bransford coll.).

Dendrobates pumilio Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, p. 393, 394 (places *typographus* as a synonym).

Dendrobates pumilio Wettstein, Sitzungb. Akad. Wiss. Wien math.-natur. Classe, Abt. I, Bd. 143, Heft 1-2, 1934, pp. 6-7 (Hamburg Farm on the Río Reventazón, Koller coll., and Carillo on Río Sucio, circa 200 m. elev., Koller coll.).

Diagnosis: Body small (20-22 mm.) squat, toadlike; limbs short, the toes and fingers free; terminal finger discs growing progressively larger from first to fourth; toe discs of first and fifth toes smallest; first and second fingers nearly equal measured on inner edge, or when juxtaposed, second a little longer; no teeth present in mouth; toes with two separate pads on top of the digital discs; body red (in life), arm and legs blue; in formalin preservation, black all over with (in some specimens) a silvery surface with black dots.

Description of species: (From K.U.M.N.H. No. 24892, Los Diamantes, C. R.). Head length (7.6 mm.) a little less than head width (6.9 mm.); eye large, its length (2.16 mm.) equal to snout length; nostril nearly terminal, the distance of nostril to median notch in lip, less than its distance from eye; no distinct canthus rostralis; loreal region vertical; snout broad, truncate, but slightly rounded seen from above; snout extending slightly beyond mouth and sloping back to lip when seen in lateral profile; eyelid width (2 mm.) two thirds of interorbital distance (3 mm.); tympanum visible but somewhat indistinct on its upper border, 1.5 mm. in vertical diameter. Choanae seen from below partially (or almost wholly) concealed by maxillary shelf; no vomerine teeth; maxillary shelf grooved below; no teeth present on jaws; tongue elongate, narrow, three times as long as wide, free for half its length.

Arm moderately long, slender; fingers without trace of web; the tips widened into distinct discs, progressively larger from first to fourth, with a maximum width of .75 mm.; first finger nearly or equally as long as second, but when juxtaposed the second extends farther; tibiotarsal articulation (heel) reaches eye when leg is drawn forward; discs of first and second toes smaller than those on other toes; edges of toes with a minute ridge, but without web; subarticular tubercles of both hands and feet flat, inconspicuous; a small metacarpal tubercle at lower base of first finger; a large, rounded, median, slightly-elevated palmar tubercle; inner and outer metatarsal tubercles distinct, subequal; a small, short, distinct, inner tarsal ridge or tubercle (somewhat variable in length).

Skin generally smooth but close scrutiny of the dorsal surfaces under a lens discloses very fine pustules; venter smooth except a fold or long ridge on each side of abdomen (similar to folds in *Eleuthrodactylus* marking ventral discoidal discs); a broad thick anal flap; under surface of thigh with an indistinct granular surface.

Color: In preservation nearly uniform grayish; in life the greater part of the body bright red or orange-red, the limbs blue.

Measurements in mm.: (K.U.M.N.H. No. 24892). Snout to vent, 22; width of head, 6.9; length of head, 7.6; arm and hand, 15; leg and foot, 30; tibia, 10; tarsus and foot, 13.

Variation: This small but conspicuous species of amphibian was found to be common in the lowland region about Los Diamantes, (near Gúapiles) Costa Rica. Some 47 specimens are present in the collections from Los Diamantes. One specimen was captured at Bataan.

The lateral abdominal folds are sharply distinct in the described specimen but in some it is less distinct. Males are equally as large as females, but the throat and breast in these have the skin loose and granular, marking externally a vocal sac; vocal slits large, rather posterior; in females a fold in the membrane of mouth is present in the usual position of the slits.

Dunn, (*loc. cit.*) has suggested that the name *pumilio* Schmidt is applicable to this species. It is a form described by Schmidt (Akad. Wiss. math.-natur. Classe. Wien, vol. 15, 1857 (1858), p. 250, pl. 11, fig. 13) and its type locality is given as follows:

"Das Vaterland unserer drei Species ist das Grenzagebiet zwischen New Granada und Costa Rica, der weg zwischen Bocca del Toro und dem Volcan Chiriqui . . . der immergrünen Regionen zwischen 5000 und 7000 ft."

The figure, pl. 2, fig. 13, shows a species that could scarcely be regarded as belonging to the species here described as *typographus*. Until a comparison of the types of *pumilio* and *typographus* by a competent observer proves them to be identical, I propose to use the Keferstein name. Cope believed his *D. ignitus* to be identical with *D. typographus*.

Dendrobates auratus Girard

Phyllobates auratus Girard, Proc. Acad. Nat. Sci. Philadelphia, Dec. 1854 (1855), p. 226 (type locality Taboga Island in the Bay of Panamá, C. B. Adams, coll.); U.S.N. Astronomical Expedition to Chili, vol. 2, p. 209, pl. 34, figs. 12-15 (side and ventral view natural size; underside of hand and foot somewhat enlarged.); Eaton, Copeia, 1941, No. 2, July 8, pp. 93-95; Dunn, Copeia, 1941, No. 2, July 8, pp. 88-93.

Dendrobates tinctorius var. *auratus* Steindachner, Verhandl. k.k. zool.-bot. Ges. Wien, 1864, p. 261, pl. 13, figs. 1, 1a-1d (In separate, pp. 22-24); Cope, Journ. Acad. Nat. Sci. Philadelphia, 2nd ser., vol. 8, 1875, p. 102. ("Numerous and exclusively from the low country not extending far inland.")

Dendrobates tinctorius (*part.*) Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collecion of the British Museum, 1882, pp. 142-143.

Hylaplesia auratus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1863, p. 49 (points out certain "imperfections" in Girard's description.).

? *Hylaplesia tinctoria latimaculata* Günther, Catalogue of the Batrachia Salientia in the British Museum, 1858 (1859), p. 125 (Isthmus of Darien).

? *Dendrobates trivittatus* var. *maculata* Peters, Monats. König. Akad. Wiss. Berlin, 1873, p. 617. (Chiriquí, M. Wagner coll.) "Der erste Finger ist, wie bie den typischen Examplareu (*sic*) etwas länger als der zweite. Oben und unter mit mehr oder weniger zahlreichen goldgelben Flecken gezeichnet."

? *Dendrobates amoenus* Werner, Verh. zool.-bot. Ges. Wien, vol. 51, May, 1901, pp. 627, 628, (type locality, Costa Rica), (Generic review).

Dendrobates auratus Dunn, Occ. Papers, Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, p. 393; *ibid*, Oct. 10, 1931, p. 412 (three records mentioned for Barro Colorado Island).

Eight specimens of this species were taken by me at Bataan, eastern lowland Costa Rica between July 20-24, 1951.

The type description given by Girard is from a specimen captured on Taboga Island, Bay of Panamá. It has been discolored by preservatives.

Diagnosis: Small frogs snout-to-vent 39 mm.; brilliantly colored above and below in green and black or golden yellow and black; lacking any webbing; distinct tympanum close to eye, the eye as long as snout; a ventral "disc" present; fingers with widened terminal discs; no maxillary or vomerine teeth; ostia pharyngea as large as choanae.

Description of species: (Details from Girard's type description). Body and head elongated depressed; head subtriangular, subtruncated anteriorly sloping inward, its length a little less than one third of the snout-vent length; nostrils small, lateral, near the tip, not visible from above; sides of head declivous; eyes large subelliptical, their horizontal diameter equal to distance of eye from tip of snout, twice as wide as distance between outer margins of eyelids; tympanum well developed, oblong, close to orbit; mouth angle extends to posterior rim of orbit; tongue narrow, elongate, posteriorly obtuse, free for half or two thirds of its length; choanae very large, subcircular, widely separated on roof of mouth, which is concave and perfectly smooth, there being no maxillary or vomerine teeth; openings of the Eustachian tubes small, not conspicuous; arms slender, the fingers reaching beyond groin; fingers free, slender, dilated at tip, the discs above divided by a groove or furrow; a large metacarpal tubercle, smaller tubercles present under first phalanx and also under second of the two external fingers; palm smooth; first finger longer than second, the fourth shortest and most slender of all. Legs stoutish, one fourth longer than body and head together, the tibia being better developed than femur; toes free, slender, depressed dilated at tips and grooved above on discs; sole smooth, the phalanges with subarticular tubercles; internal metatarsal tubercle elongated the outer rounded; both moderately developed; inferior surface of thigh granular, the skin otherwise perfectly smooth, but exhibiting minute pores under a lens, both above and below.

Color: Above metallic golden; beneath a uniform bluish predominates.

Measurements in mm.: (taken from K.U.M.N.H. No. 30292). Snout to vent, 39; width of head, 10.2; length of head, 10; length of arm, 25; leg, 52.5; tibia, 13; foot and tarsus, 22.5.

Remarks: The details of the figure given differ somewhat from

the detailed description; as, for instance, the outer metatarsal tubercle is elongated, the inner rounded instead of the opposite as stated in the description.

Cope (P.A.N.S. Phil. 1863, p. 49), who seemingly had Girard's specimens before him gives the following additional data. Muzzle rounded; first finger shorter than second as in *tinctoria;* no occipital ridges, the neural spines only slightly thickened, discs on toes one fourth of extent of tympanum; discs of fingers one half of same; ground color black or brown; crown and muzzle surrounded by a golden band; two postscapular transverse annuli on each side, in contact on the median line. A yellow annulus on each inguinal region, smaller rings on humerus and tibia. "On pale specimens these markings are represented by refulgent bands which are readily destroyed or passed over; hence the imperfections in Girard's description."

Certain other characteristics of this species evident in the Bataan specimens are: skin shining smooth above and on sides, as well as on chin and anterior part of venter; tympanum distinct, its upper and posterior edges indistinctly outlined; a thickened ridge or indistinct fold runs diagonally from eye to arm insertion; posterior part of venter with some granules; part of ventral, and much of posterior surface of thigh granular; anal flap distinct, its posterior edge partly covering four large pustular tubercles which may be partially confluent; tibiotarsal articulation reaches eye; limbs folded at right angles, the heels overlap when legs are folded usually less than one millimeter; a skinfold from axilla along sides of abdomen meet in front of thigh, forming a ventral "disc"; fingers and toes much widened at tips, with adhesive pads below; first finger actually longer than second but when juxtaposed the second extends farther forward; second and fourth fingers reach forward an equal distance; greatest width of third finger disc 2.05 mm.; of first finger, 1.3 mm.; palmar tubercle large, distinct, rounded; a small indistinct tubercle at base of first finger; basal subarticular tubercles well defined, rounded; outer tubercles on third and fourth fingers smaller, less distinct.

Largest distal discs on toes (2.8 mm.) smaller than largest finger discs; inner and outer metatarsal tubercles distinct, with a suggestion of a median tarsal tubercle sometimes evident; a trace of a lateral ridge on inside edge of fingers and toes; a small tarsal ridge begins behind inner tarsal tubercle and terminates in a short more

elevated ridge midway of tarsus. In preservative lower eyelid white, with a black upper border.

Tongue, narrow, elongate, rounded behind, unnotched, free for half its length; male with two lateral vocal slits near jaw; openings of Eustachian tubes lateral equally as large as choanae, which likewise are lateral in position.

Specimens in my collection (E.H.T.-H.M.S.) from Panamá differ from the Costa Rican forms in no essential structural detail. The specimens, however, now show no trace of their former color or markings.

The figure in Steindachner (*loc. cit.*) shows markings similar to the description given by Cope.

All specimens I have encountered were roving about on the forest floor at some distance from streams or rivulets, but in a region where tiny rain pools were to be found. The presence of adhesive digital discs permit them to climb trees, but none was found in such a place.

Theodore Eaton, Copeia, 1941, pp. 93-95, gives an excellent account of the curious behavior of the males in bringing tadpoles on their backs to a small water-filled cavity in a tree. He tells of removing all tadpoles from the water hole only to find that on a later visit others had been carried to the place. These, too, were removed by him, and still others were brought by the males later.

At Bataan the specimens I observed, when disturbed, often took refuge in the numerous aerial roots of a certain palm tree where the roots entered the earth, and could not be induced to leave this shelter; nor could they be seized since the spines on the roots and their thickness prevented a hand from reaching the refugees.

The secretions from the skin of this species are highly poisonous to other frogs if they are carried together with them in a collecting bag. I did not note any effect from handling them myself.

Duméril and Bibron, Herp. Gen. vol. 8, pp. 653, 654, give *Hyla aurata* Maximillian zu Wied. as a questioned synonym of *Dendrobates tinctorius* Wagler. If this synonymy is correct, then the name *aurata* Girard is untenable, a matter that cannot be decided at this time.

The specimens from Bataan have the terminal digital discs as wide as the tympanum, and may differ in this point from Girard's type. Other differences might be evident if the types were compared with my specimens.

Genus PHYLLOBATES Duméril and Bibron

Type of the genus: *Phyllobates bicolor* Bibron.

The original description of this genus appeared in the Herpétologie Générale, vol. 8, p. 637, and the single species *Phyllobates bicolor* Bibron is included.

Boulenger accepted the genus *Phyllobates,* but has included a number of forms now regarded as belonging in the Leptodactylidae. Boulenger had no direct knowledge of the genus (see Catalogue Batrachia Ecaudata, p. 194) and it would seem that at first the essential characters of the genus were not sensed by Cope, who described in it several species belonging to a different family. Later Cope did separate certain of these and for them erected the genera *Syrrhophus* Cope, *Hypodictyon* Cope and *Malachylodes* Cope.

Werner (1901) revised these small frogs, placing them, as certain authors have done, in the genus *Dendrobates.* He described *D. amoenus* which is definitely a *Dendrobates.*

Barbour and Noble (1920) undertook the study of the genus *Phyllobates* but overlooked or failed to discern that the species described by Schmidt (1858) *lugubris,* and *talamancae* a species described by Cope (1875) from Costa Rica, both under the generic name of *Dendrobates,* were actually members of the genus *Phyllobates.*

Dunn and Barbour (1921) described as new, *Phyllobates beatriciae* from near Zent, Costa Rica, and redescribed *Dendrobates talamancae* Cope (from Old Harbour, Costa Rica) recognizing it as a *Phyllobates.* They recognize *Dendrobates lugubris* Schmidt (5000 to 7000 ft. between Bocas del Toro and Volcán Chiriqui, Panamá) and *Dendrobates truncatus* Cope (Panamá) as belonging to the genus *Phyllobates.*

Later Dunn (1924) with more materials at hand recognizes *Phyllobates talamancae* (Cope), and *Phyllobates latinasus* (Cope); but the species *Phyllobates beatriciae* described in the previous paper is placed in the synonymy of *Phyllobates lugubris* (Schmidt), and he states that the previous redescription of *talamancae* was based on a male and female belonging to different species, only one of which was *talamancae.* Localities given for *latinasus* in Costa Rica are Santa Cecilia, for *talamancae,* Santa Cecilia and Suretka; and for *lugubris,* Talamanca valley and Zent.

In 1931 he describes as new a small species *Phyllobates flotator* the type locality being Barro Colorado Island. One (paratype?)

specimen is listed from Suretka, Costa Rica. The suggestion is made that *Dendrobates tinctorius vittatus* Cope from Buenos Aires belongs in *Phyllobates lugubris*. In 1933 he announced the intergradation of *Phyllobates flotator* and *Phyllobates nubicola;* and *flotator* is reduced to subspecific status, as *Phyllobates nubicola flotator* Dunn. In 1940 he refers *Phyllobates lugubris* to the genus *Dendrobates*.

Four species of the genus are represented in the fauna of Costa Rica.

KEY TO COSTA RICAN SPECIES OF PHYLLOBATES

1. Third finger of male swollen; a lateral streak starting from the middle of the black lateral band in groin and reaching eye; male with white throat; snout-to-vent 17 mm . . . . . *nubicola flotator*
   Third finger of male not swollen; not so marked 2
2. Venter black in both sexes with or without some lighter reticulation; black above; cream or yellowish line from tip of snout, across eyelid to rump or groin; venter and limbs with some light markings or reticulations; a white stripe from below eye to arm insertion. (23 mm.) . . . . . *lugubris*
   Venter yellow or whitish; chin of males may be black 3
3. Black or dark brown above, the venter, (save on chin and breast of males which are blackish), whitish or yellowish cream; a yellowish or cream dorsolateral line; a lateral dark stripe present. (23 mm.) . . . . . *talamancae*
   Brown above with a black streak from eye to eye around snout; a white streak in front of thigh on a broad black lateral stripe; upper lip white; legs pale with dark bars of brown on both leg and foot. (20 mm.) . . . . . *pratti*

Phyllobates lugubris (Schmidt)

Figure 10

Dendrobates lugubris Schmidt, Sitzungsb. k. Akad. Wiss. math.-natur. Cl. Wien, 1857, pp. 12-13 (type locality not indicated); and Denkschr. k. Akad. Wiss. math.-natur. Wien, Bd. 14, pt. 2, 1857 (1858) p. 2, fig. 14 (type locality, road between "Boca del Toro und dem Vulcan Chiriqui . . . zwischen 5000 und 7000 (ft.)", V. Warszewicz coll.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 1882, p. 145.

Hylaplesia lugubris Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 88 (no specimens).

Hylaplesia tinctoria (*part.*) Günther, Catalogue of the Batrachia Salientia in the Collection of the British Museum, 1858 (Feb. 12, 1859), p. 125 (Var. A.); Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1900, p. 207.

Phyllobates beatriciae Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Aug. 17, 1921, p. 159 (*part.*) (Victoria farm near Zent, not far from Puerto Limón, Costa Rica, Dunn coll.); Occ. Papers Mus. Zool. Univ. Michigan No. 151, July 1, 1924, p. 5 (places the species in the synonymy of *lugubris*).

Phyllobates talamancae (*part.*) Barbour and Dunn, Biol. Soc. Washington, vol. 34, Aug. 17, 1921, p. 159, 160.

Phyllobates lugubris (*part.*) Dunn, Occ. Papers Mus. Zool. Univ. Michigan No. 121, July 1, 1924, p. 5, 7, 10 (confused with *Phyllobates flotator* [*fide* Dunn], data given on tadpole); Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 390-392.

D[*endrobates*] *lugubris* Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, p. 110 (apparently considers *lugubris* Schmidt a species of the genus *Dendrobates*).

Diagnosis: This small species (23 mm.) is characterized by an almost entirely black coloration above and below; dorsolateral light stripes from rump pass across eyelid to snout tip; no lateral stripe; venter and limbs with elongate irregular light markings; a white stripe from arm insertion to below eye; digital discs have a pair of small thickened pads on their dorsal surface; (in life the black of belly may have a greenish color, and the throat and legs may have a yellowish or pinkish wash).

Description of species: (from K.U.M.N.H. No. 24908, Morehouse Finca, ♀). Head width (7.5 mm.) less than head length (8.7 mm.); eye large, its length (3 mm.) slightly shorter than snout (3.3 mm.); tip of snout rounded, truncate; distance from nostril to eye slightly greater than distance to middle notch of upper lip; distance between nostrils equals eye length; upper eyelid width in interorbital width 1.2 times; lower part of tympanum distinct, its diameter twice the eye length; choanae small, concealed under shelf of maxilla when seen from below; no vomerine teeth; maxillary teeth present; tongue two and one-half times as long as wide, free for nearly half its length; (male with vocal slits).

Skin of back with minute pustules or granules visible under lens; sides, venter, chin, limbs (generally), smooth; (area below anal opening may be slightly areolate or granular).

Arm slender, elongate, the digits with small terminal pads, subequal in size, the first slightly smaller, the third slightly larger than others; subarticular tubercles moderately distinct, not elevated; a large rounded median palmar tubercle; a small inner tubercle at base of first finger; first finger metacarpals not bound together with the other metacarpals; first finger a little longer than second; no trace of web.

Leg rather long, the tibiotarsal articulation to middle of eye; no trace of a web between digits; subarticular tubercles indistinct; a larger inner and smaller outer metatarsal tubercle; a small indistinct tarsal tubercle or ridge (sometimes tending to reach to the inner metatarsal tubercle; heels touch when limbs are folded at right angles to body; pads on toes larger than those on fingers, those of three middle toes largest.

FIG. 10. *Phyllobates lugubris* (Schmidt), from K.U.M.N.H. No. 24908; Morehouse Finca, 5 mi. southwest Turrialba; actual snout-to-vent length, 22.5 mm.

Measurements in mm.: Snout to vent, 22.5; width of head, 7.5; length of head, 8.7; head to arm insertion, 8.8; arm and hand, 17; leg, 31; tibia, 10.8; foot and tarsus, 14.4.

Color.: General color black with yellowish stripe extending from the rump, across eyelid and around tip of snout; a narrow white line beginning under middle of eye runs back and onto dorsal surface of arm; chin and throat intense black; abdomen and sides and under side of limbs black, with white or silvery vermiform markings or spots; anterior and ventral face of femur, tibia and tarsus with similar white marks; a light mark across dorsal surface of thigh at base; toes and fingers of a lighter shade than body; posterior surface of thighs black with minute white punctations.

Remarks: The species was taken on the banks of the Río Reventazón on the I.A.I.A. farm near Turrialba, Costa Rica (4 spec.); on the Morehouse Finca, 4 mi. S Turrialba, along a small rivulet (1 spec.); and at Los Diamantes, 1 mi. S Guápiles, Costa Rica, along th banks of a small river (3 spec.). The preserved material shows complete similarity in characters although in life one of the Turrialba specimens was somewhat greenish on the venter. All were black above with stripes present on the back. One specimen, taken at Turrialba (a male, R.C.T. No. 227) displayed a yellowish area on the throat, covering the vocal sac, while the belly itself was yellow-green. The cream line on the lip and the dorsolateral lines were the same color as those in the female specimen. A wash of pink was present on the dorsal surface of the thigh. This pink color disappears quickly in alcohol. The vocal sac has two lateral, longtitudinal, external folds. The internal vocal slits are ample.

Phyllobates pratti Boulenger

Phyllobates pratti Boulenger, Ann. Mag. Nat. Hist., ser. 7, vol. 3, Apr. 1899, pl. 11, fig. 3 (type locality, Santa Innes, N. of Medellin,, Colombia, A. E. Pratt, coll.); Barbour and Noble, (*part.*), Bull. Mus. Comp. Zool. Harvard Col., vol. 63, no. 8, Jan. 1920, pp. 398, 399, 400, 401 (states that Boulenger considers *P. pratti* a synonym of *latinasus.*).

Phyllobates latinasus Dunn, (*part.*), Occ. Papers Mus. Zool. Univ. Michigan, No. 151, July 1924, pp. 5, 6, 7, 9, 10 (Santa Cecelia, Costa Rica, and Panamá localities); Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 389, 391 ("What I called *talamancae* in 1921 was based on one specimen of *talamancae* and one of *latinasus*, and I properly segregated *latinasus* in 1924, I included the present *flotator* under *talamancae.*" After listing specimens of *latinasus* from localities in Panamá and Costa Rica, Dunn states: "The specimens seen are all the same species, and different from any other seen but close to *kingsburyi.* Whether they are Cope's species is perhaps questionable. *Latinasus* was described as 30 mm. long, which agrees with *kingsburyi,* but not with what I am calling *latinasus,* of which I have seen none over 21 mm. Otherwise the description agrees better with what I am calling *latinasus* than with what I am calling *kingsburyi.*").

Diagnosis: A diminutive *Phyllobates* without webbing on fingers or toes; discs well-developed smaller than the tympanum; heel reaches to eye; skin smooth, finely shagreened on back.

Description of species: "Snout rounded, moderately prominent, not quite so long as the diameter of the orbit; loreal region vertical; nostril a little nearer to the tip of the snout than the eye; interorbital space broader than the upper eyelid; tympanum rather indistinct, hardly half the diameter of the eye. Fingers moderate, first extending slightly beyond second; toes moderate, free; disks well developed; smaller than the tympanum; two small metatarsal tubercles, inner oval, outer rounded; a small oblique tubercle or ridge in the middle of the inner side of the tarsus. The tibiotarsal articulation reaches the eye. Skin smooth, finely shagreened on the back. Brown above; a black streak from eye to eye round the snout; upper lip white; broad black lateral stripe and a white streak in front of the insertion of the thigh; limbs pale, with a dark brown streak on the thigh and some dark brown bars on the leg and foot; lower parts white. From snout to vent 20 mm.

Remarks: Dunn has referred this form to *Phyllobates latinasus*[*] Cope from the Truando region, Colombia. Unfortunately the type of Cope's species is lost, but in Cope's opinion the form was different enough to warrant a new generic designation.

Description of species, Phyllobates latinasus (Cope): (From type description.) Head elongate; front plane transversely, gently arched longitudinally, a little wider than from orbit to end of muzzle. The latter is prominent, broad, and concavely truncate; external nares lateral. Loreal regions plane. Internal nares widely separated. Tympanum round, equal one-fourth extent of orbit, whose diameter equals length of muzzle from orbit. A slight web between outer fingers, of which the second is shorter than the inner or first; one large carpal tubercle on metacarpus of thumb. A dermal fold on the tarsus. Two metatarsal tubercles. The carpus reaches the end of the muzzle, and the heel the anterior border of the orbit. Length of head and body 3" (three centimeters).

"Above brown; a black band across end of muzzle and loreal region, through eye to groin; pale-bordered above on the muzzle, and interrupted by an oblique white line from the femur. Femur

[*] *Phyllobates latinasus* Cope, Proc. Acad. Nat. Sci. Philadelphia, 1863, pp. 48-49 (type locality, Truando region, New Granada).
Colostethus latinasus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 130 (type of new genus *Colostethus*); Journ. Acad. Nat. Sci. Philadelphia, vol. 6, pt. 2, Sept. 1867, p. 197 (new family *Colostethidae*).
[*Phyllobates*] *latinasus* Barbour and Noble, Bull. Mus. Comp. Zool. Harvard Col., vol. 63, no. 8, Jan. 1920, pp. 398, 399, (*part.*).

dark posteriorly, tibia cross-banded; (color of limbs not well preserved). Beneath pale, immaculate." The type is from "Truando region, New Granada."

Remarks: Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 130, created the genus *Colostethus* for the species *Phyllobates latinasus.* It was characterized by the absence of a manubrium; membranous xiphisternum; digits free with dilations; external metatarsals bound; no vomerine teeth; prefrontals widely separated by the largely produced bony superior ethmoid plate. Maxillary teeth present; distal phalanges with terminal transverse limb.

Still later, (Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, 1867, p. 197) he established the family *Colostethidae* for this same species, adding another pertinent character: no metatarsal tubercles. Barbour and Noble (Bull. Mus. Comp. Zool. Harvard College, vol. 63, no. 8, Jan. 1920) place *Colostethus* as a synonym of *Phyllobates* stating "There remains another genus which should be referred to the synonymy of *Phyllobates. Colostethus,* known only from the type specimen of *C. latinasus,* was described by Cope as lacking the omosternum. The type specimen cannot be found in either the U. S. National Museum or the Academy of Natural Sciences of Philadelphia. Specimens very similar to *C. latinasus* but possessing an omosternum have been found in Ecuador and Colombia. . . . Boulenger has recently advised the senior author by letter that he considers his *Phyllobates pratti* referable to *C. latinasus.* Boulenger evidently considers that Cope overlooked the omosternum, a very probable oversight, in view of the smallness of the type of specimen."

Since the type of Cope's species cannot be found there is no absolute certainty that the species occurring in Costa Rica should have this name.

Phyllobates talamancae (Cope)

Dendrobates talamancae Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 102, pl. 23, fig. 6 (type locality Old Harbor on the eastern coast of Costa Rica, Gabb, Coll.). (The village of Old Harbor, said to have been 20 miles south of Port Limón, is not now in existence.)

Hylaplesia talamancae Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études des Batraciens de l'Amérique Centrale, livr. 2, 1882, pp. 88-89 (data from Cope); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 1882, p. 145; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1900, p. 208.

Phyllobates talamancae (*part.*) Dunn, Proc. Biol. Soc. Washington, 1921, pp. 159-160 (mixed *talamancae* and *latisasus, fide* Dunn); Occ. Papers Mus. Zool. Univ. Michigan, No. 151, July 1, 1924, pp. 2, 4, 5, 6, 7, 9, 10, 11 (confuses *talamancae* and *flotator, fide* Dunn).

Phyllobates talamancae Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Apr. 18, 1931, pp. 389, 390 (reported from Suretka and Santa Cecilia, Costa Rica; Gatún, Panamá); *ibid.*, Oct. 10, 1931, pp. 412, 419.

Diagnosis: This small inconspicuous species may be characterized as follows: Small frogs, maximum size about 23 mm., lacking vomerine teeth, but with maxillary and premaxillary teeth present; tips of digits dilated, with paired, thickened pads on their dorsal surface. First finger distinctly longer than second; blackish brown above with a yellowish (in life) stripe from groin to eye; a lateral dark stripe bordered below by a light stripe that reaches along edge of lip to tip of snout.

Description of species: (K.U.M.N.H. No. 24904). Head length (8.1 mm.) greater than width (7.6 mm.); loreal region nearly vertical; eye large, its length (2.8 mm.) equals length of snout; area about lateral nostril slightly swollen making the terminal width of snout slightly greater than part immediately following nostrils; interorbital width equals eye length, one and four fifths width of an eyelid; lower half of tympanum more or less visible, its diameter in eye length 1.75 times; choanae hidden by maxillary shelf when palate is seen from below; maxillary and premaxillary teeth present; vomerine teeth absent; tongue elongate, narrow, widened somewhat posteriorly, free for half its length.

Arm moderately long; metacarpal of first finger not bound together with other metacarpals; the first finger distinctly longer than second; discs at tips rather large, that of first finger nearly as large as those of other fingers; subarticular tubercles prominent, large; a large rounded median palmar tubercle; a small, somewhat elongate outer tubercle; leg moderately long, tibiotarsal articulation reaches to eye; an elongate elevated inner metatarsal tubercle, and a smaller elevated outer; a small inner tarsal tubercle or ridge somewhat in advance of the middle of the tarsus; toe discs larger than finger discs, that on fourth toe largest; no supernumerary tubercles; skin of back and sides, limbs and venter generally smooth; area about anal opening somewhat pustular.

Color: Dark blackish brown above with dorsolateral yellow lines from groin to around eyelid; below this a broad black stripe reaching snout tip; this bordered below by a narrow whitish or yellow line that borders all of upper lip; below this line on sides some indistinct darker marbling; belly and chin uniform flesh white; arms lightly pigmented, leg with the front of femur light, and a small line from groin joining it to form a hook-shaped mark; lighter and darker indefinite marking on tibia, tarsus, and foot. Underside of foot a little darker than underside of hand.

Measurements in mm.: Snout to vent, 23; length of head, 8.1; width of head, 7.6; length of eye, 3.2; length of snout, 3.4; arm, 15; hand, 4.5; leg, 32; tibia, 10.2; foot and tarsus, 13.4.

Remarks: The males of this species are of nearly the same size as females (18-20 mm.), and there is more black color below the lateral light line. The throat and chin are blackish and there are two longitudinally folded areas on chin, marking the vocal sac. The vocal slits in mouth are elongate, and the sac itself is at least partially divided, seemingly extending on to the breast and back as far on sides as arm insertion. One male displays much clouding on the venter. Certain of the specimens have lateral abdominal folds suggestive of a ventral abdominal "disc."

The following notes were made on certain specimens in life.

No. 24902 ♀. "Chin yellowish white; venter whitish flesh; thighs with a salmon wash; blackish on back, with gray to bronzy stripes; lips yellowish white; groin and an area on back of thighs pinkish; arms and legs somewhat olive above, with some darker spots."

A male, R.C.T. No. 364. "Coal black on chin, throat and breast; salmon wash on underside of thighs; a few minute whitish dots in anal region."

Twelve specimens are in the collection from the Morehouse Finca, four miles south of Turrialba, and 32 specimens from the Río Reventazón near the Inter-American Agricultural Farm at Turrialba.

Phyllobates nubicola flotator Dunn

Phyllobates flotator Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 389-390, 392 (type locality Barro Colorado Island, Canal Zone, Panamá. Specimens listed from Suretka C.R. and other Panamanian localities); *ibid.* vol. 5, Oct. 10, 1931, pp. 412-419.

Phyllobates nubicola flotator Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, June 7, 1933, p. 74.

Diagnosis: A *Phyllobates* with black and white coloration; a lateral streak starting from middle of black lateral band in groin and reaching eye; male with white throat; male with swollen third finger; tadpole with no labial teeth and much produced lower lip.

Description of species: (from the type description.) Adult male; loreal region vertical, slightly concave; interorbital space broader than upper eyelid; tympanum indistinct, ⅓ size of eye; disks well developed, smaller than tympanum, third finger swollen, as wide as disk, disk of toe I half size of toe II; disk of toe V half size of disk of toe IV; top of toe I misses penultimate phalanx of toe II; tip of toe II reaches antepenultimate phalanx of toe III; tip of toe III reaches antepenultimate phalanx of toe IV; toe IV 2½ phalanges beyond toe V; tip of toe V just past penultimate phalanx of toe III;

two metatarsal tubercles; one tarsal tubercle; heel barely to eye; skin finely granular; gray above; white below; sides black; light line from groin to eye obliquely through black; upper lip white; dark line on anterior edge of thigh; dark line on dorsal surface of thigh running into another dark line on posterior edge of thigh at knee, "anvil-shaped marking"; dark anal triangle; legs not barred; head to snout 17 mm.

Variation: A female from the same locality is similar save for the third finger not being swollen. A specimen from Cana in Darien has slightly longer third and fifth toes.

FAMILY LEPTODACTYLIDAE Berg

Leptodactylidae Berg, Anal. Mus. Nac. Buenos Aires, vol. 5, 1896, p. 161.

This family has representatives of four genera in Costa Rica. These are *Eupemphix, Eleutherodactylus, Microbatrachylus* and *Leptodactylus.* These genera may be distinguished by the following synopsis.

KEY TO COSTA RICAN GENERA OF LEPTODACTYLIDAE

1. Small toadlike animals without teeth on vomer or maxillary ..... *Eupemphix*
   Variable forms with maxillary teeth; vomerine teeth present or absent 2
2. Diminutive species with a large inguinal gland present; vomerine teeth ..... *Microbatrachylus*
   Larger species with vomerine teeth usually present, inguinal gland lacking or very small 3
3. Mesosternum forming a bony style; vomerine teeth in elongated transverse series ..... *Leptodactylus*
   Mesosternum cartilaginous, usually with a double, arrow-shaped posterior termination; vomerine teeth not in strongly transverse series ..... *Eleutherodactylus*

Genus LEPTODACTYLUS Fitzinger

Leptodactylus Fitzinger, Neue Classification der Reptilien . . ., 1826, pp. 38, 64.

Four species are recognized in the Costa Rican Fauna, one of which is very large, reaching a size exceeded only by that of the large *Bufo marinus.* The forms may be recognized by the following key. *Leptodactylus labialis* has been reported for Panamá. I have seen no Costa Rican specimens.

KEY TO COSTA RICAN SPECIES OF LEPTODACTYLUS

1. Heel not reaching to middle of eye; males with two horny spines on first finger; toadlike forms 2
   Heel reaching front of eye or between eye and tip of snout; no horny spines on first finger of males; froglike forms 3

2. Very large toadlike species; a pair of horny excrescences on breast in males; heel reaching middle of eye; dorsolateral folds present; canthus rostralis moderately distinct; toes without trace of web but with traces of fringes; length to 160 mm. or more; skin practically smooth ..... *pentadactylus dengleri*

Smaller toadlike species less than 50 mm. in length; no horny excrescences on breast; heel reaches to tympanum; skin with rows of minute horny tubercles, toes with small web remnants and a trace of fringes on sides of digits ..... *melanonotus*

3. Two glandular ridges on each side of vertebral line; nostril nearer eye than median tip of snout; vomerine teeth in arched series behind choanae from near median line to level of outer edge of choanae; interorbital width greater than eyelid; heel to front of eye; gray with four more or less distinct black, longitudinal lines; tibia with a wide longitudinal band; 37 mm. ..... *quadrivittatus*

Glandular fold from eye to groin, and one from eye to shoulder; nostril nearer tip of snout than eye; interorbital space equals upper eyelid; heel to midway between eye and tip of snout; pale brown, glandular folds black-edged; a dark brown triangular blotch on the back of head; lacking four dorsal lines; 43 mm. *maculilabris*

Leptodactylus pentadactylus dengleri Melin

Figure 11

Rana pentadactyla Laurenti, Specimen medicum, exhibens Synopsis Reptilium emendatum cum Experimentis cerca Venena et Antidota Reptilium Austriacorum Viennae, 1768, p. 32 (type locality- the species is based on a figure of *Rana maxima Virginiana* Seba, Thesaurus, vol. 1, pl. 75, fig. 1, a species of unknown provenance).

Cystignathus pentadactylus Peters, Monatsb. Akad. Wiss. Berlin, 1872, p. 198. (Good bibliography).

Leptodactylus pentadactylus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, pp. 241-242. Günther, Biol. Cent. Amer. Rept. Batr., 1900, p. 212; Barbour, Mem. Mus. Harvard Col., vol. 41, 1914, p. 251; Lutz, Mem. Inst. Oswaldo Cruz, vol. 19, 1926, pp. 143-144, pl. 30, figs. 1, 2, 5, 6; pl. 34, figs. 2-3; pl. 36, figs. 1-2; Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 410, 418; and Dunn, in Barbour, Ann. Rep. Barro Colorado Island, Biol. Lab. Panama, Canal Zone, 1931, p. ? (Barro Colorado Island); Schmidt, Smithsonian Misc. Coll., vol. 89, No. 1, 1933, p. 4 (Porto Bello, Canal Zone); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, 1933, p. 64.

Leptodactylus pentadactylus dengleri Melin,* Medd. Göteborgs Mus. Zool., ser. B. Band 1, No. 4, 1941, pp. 51-52, fig. 28.

Leptodactylus pentadactylus pentadactylus Andersson, Ark. för Zool., Band 37 A, no. 2, 1945, pp. 47-52, fig. 16 (Costa Rica, Nicaragua, and Ecuador).

* Melin presumably has used the description, given by Lutz (*loc. cit.*) for his concept of the type form of the species. The figures given by Doctor Lutz (*loc cit.*), show narrow-headed, and broad-headed types, and considerable variation in coloration is indicated. The type locality is not fixed, and there is no certainty that Doctor Lutz took into consideration a probable type locality other than a very general one. From data given by Melin, it is probable that the form occurring in Costa Rica is closer to *L. p. dengleri* Melin than to the typical form. Whether a series would show subspecific differences from *dengleri* is a fact that cannot be decided with the material at hand. Andersson (Arkiv för Zoologi, Band 37A, no. 2, 1945) does not take into account the form described by Melin, but for specimens, I presume to be the form described by Melin, he uses the name *p. pentadactylus* and another form is described as *Leptodactylus pentadactylus rubidoides.* The synonymy must of necessity refer in part to other subspecies; however, I cannot attempt to distinguish those that refer only to this subspecies.

Melin has recently (1941) described a subspecific form of the species as *Leptodactylus pentadactylus dengleri.* Comparison of Costa Rican specimens show that they agree best with that form described from Rogue, Peru, and they are here treated under this name.

Diagnosis: A very large toadlike form, the larger males measuring 130 mm. and the large females 135-160 mm.; heavy dorsolateral folds; a supratympanic fold completely separated from the dorsolateral fold extending diagonally to above the arm; males with arms greatly thickened; pollex well developed, protruding, bearing a horny cap and a lateral spine; a pair of horny excrescences on breast of males; a strongly developed preinguinal gland; lateral glands absent or less developed in the female. Vomerine teeth in arched series between choanae.

Description of species: Head broad, its width (62 mm.) greater than length (49 mm.); canthus moderately distinct, rounded, curving forward to the nostril; loreal region only slightly concave, sloping obliquely to lip; tympanum distinct (9.5 x 8 mm.) its greatest diameter distinctly less than length of eye (14.5 mm.); eye greater than its distance from nostril (13 mm.); width of an eyelid (13 mm.) greater than interorbital width (12 mm.); tongue large, oval, notched behind; vomerine teeth in two curving series between and partly behind the irregularly transverse choanae; vocal slits short; the sac not ample.

Arm short; greatly thickened (♂) (or slender in ♀); digits with blunt somewhat rounded tips, not or but slightly dilated; first finger much longer than second; pollex strongly developed, terminating in a free point 5 mm. in length, bearing a terminal cap of black horn for nearly its entire length; a lateral spine also present; first and third fingers nearly equal, the fourth longer than second; subarticular tubercles distinct; a large prominent metacarpal tubercle at base of pollex; palmar tubercle large, less distinct, partly bifid; heel reaching to middle of eye; toes without webs, but with traces of lateral fringes; a small inner metatarsal tubercle, outer tubercle still smaller but distinct; an inner tarsal fold; fourth toe distinctly thicker and heavier than other toes.

Skin smooth; a dorsolateral fold begins behind eye and extends to side of rump, sometimes broken posteriorly; a supratympanic fold begins at corner of eye and passes diagonally to a point above arm; a large inguinal gland, with two or three other lateral glandular areas present; usually glandular folds in region of vent and side

of rump. A pair of heavy, horny excrescences on breast, seemingly developed from small pectoral glands, and may be shed, and formed again (at least they are absent in some males and present in others); minute pearl-tipped pustules or tubercles cover greater part of the chin in males and are scattered over breast and postpectoral regions; posterior part of the ventral side of thigh, as well as lower part of the posterior face with minute granules; vent high with a small,

FIG. 11. *Leptodactylus pentadactylus dengleri* Melin. K.U.M.N.H. No. 25716; Los Diamantes, Costa Rica; snout-to-vent length, 136 mm.

seemingly grandular anal flap; pair of glands lateral to vent; venter and chin of females smooth.

Color: Grayish brown, with or without a dorsal pattern of slightly darker brown transverse markings beginning on the snout; a brown line follows the dorsolateral fold and a black one passes from nostril to eye, continuing behind eye along the supratympanic fold; one or two black dashlike spots above arm; lips with four dark brown spots, the median anterior pair nearly black, reaching to near nostril; arm not conspicuously barred; legs with numerous blackish bars and spots; venter dirty gray, mottled darker; throat of males dark.

Measurements in mm. of K.U.M.N.H. No. 25717, Turrialba, Costa Rica: Snout to vent, 143; width of head, 62; length of head, 49; length of eye, 14.5; length of snout, 19; arm, 75; hand, 35; leg, 195; tibia, 70; foot and tarsus, 101.

Remarks: These great frogs are often found in excavations below rotting logs, presumably made by some other animal. The eggs are laid in great masses of foam in moist spots or at the edge of small rain pools. One such mass filled a four-liter bucket with a little left over. The powerful booming voice carries a distance of more than a kilometer under ordinary circumstances.

The skin secretions are irritating to the soft skin between ones' fingers, and are painful if they enter scratches or small cuts in the skin.

Leptodactylus melanonotus (Hallowell)

Figure 12

Cystignathus melanonotus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 485 (type locality Nicaragua); Cope, Proc. Amer. Philos. Soc. vol. 18, p. 269.

Leptodactylus caliginosus (part) Nieden, Das Tierreich, Lief. 46; Anura I, 1923, pp. 491-492.

Leptodactylus melanonotus Dunn, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, 1931, p. 406 (western Panamá and Darien); *ibid.* vol. 8, 1933, p. 67, El valle de Anton, Panama; Proc. Acad. Nat. Sci. Philadelphia vol. 92, 1940, p. 107.

Diagnosis: One of the smaller species of the genus (less than 50 mm.) with two horny spines on outer edge of the first finger, lacking horny excrescences on breast but often with horny excretions on surface of glands, on side of neck in front of arm insertion, on sides behind arm insertion and on the outer posterior surfaces of thighs; heel to tympanum; skin with irregular rows of minute horny tubercles; small web remnant and at least traces of fringes on sides of digits.

The original description of the type, a presumed young specimen from Nicaragua, is brief, omitting most of the essential diagnostic characters. It is given here in full.

Cystignathus melanonotus nob.

Special characteristics: "Color black above, with black spots; a black subround spot between the eyes; under parts white, minutely mottled and spotted with brown; body and extremities slender.

Description: "Head of moderate size, eyes not remarkably prominent, tympanum well developed, tongue obcordate, not notched posteriorly; palatine teeth in two transverse rows; the anterior margin on a line with the posterior margin of the posterior nares; color as stated in the specific character.

Dimensions: "Length of head 4 lines; greatest breadth 3; length of head and body 9 lines; length of anterior extremities 6 lines; of posterior, 1 inch; of thigh 3 lines; of leg 4; of tarsus 2 lines; of foot to extremity of longest toe 4½ lines.

Habitat: "Nicaragua. One specimen; perhaps the young of a larger animal."

Description: (From K.U.M.N.H. No. 28187, La Suiza, 5½ mi. SW Turrialba, Costa Rica, July 15, 1947). Body rather slender, the snout-to-vent length 40 mm.; head narrow, its width (16 mm.) less than length of head (19 mm.); canthus wanting with a very slight depression in loreal region; nostril equidistant from eye and median point on upper lip; width of an upper eyelid equal to narrowest interorbital distance; a strong thickened fold from eye, covers upper edge of tympanum, behind which it angles downward to above arm insertion where it terminates in a glandular area; this separated from another glandular area by a groove; tympanum longitudinally oval, its length 2 mm. its height 1.6 mm., separated from the eye by a distance of 2.8 mm. equal to the distance between nostrils; length of eye opening (4.2 mm.) less than median length of snout (4.6 mm.); choanae small, the distance between them (3.1 mm.) nearly 6 times the diameter of a choana; vomerine tooth fasciculi slightly diagonal, distinctly behind level of choanae and not reaching laterally to their inner level; tongue slightly notched behind, wider and thicker posteriorly than anteriorly, free for nearly a fifth of its length; ostia pharyngea nearly double the area of choana; (males with vocal sacs?).

Arm short the wrist not reaching beyond snout; first finger equal or minutely longer than second; fingers unwebbed, but a distinct fringe or sharp ridge on inner side of the second and third fingers;

FIG. 12. *Leptodactylus melanonotus* (Hallowell); K.U.M.N.H. No. 28187♀; La Suiza 5½ mi. SW Turrialba, Costa Rica; Snout-to-vent, 41 mm.

slight subterminal swellings, the tips narrower than digits; a strongly elevated inner metacarpal tubercle; a prominent, partly bifid outer palmar tubercle; an indistinct tubercular ridge on under side of arm. Some pustular tubercles below elbow; subarticular tubercles four; indistinct supernumerary tubercles on palm; (male with two spines on thumb; vocal slits present).

Leg short, heels not touching when legs are folded at right angles to body; limb brought forward, tibiotarsal articulation touches

back edge of tympanum; a small web remnant between toes, with fringes varying in width, extending to near tips of toes; a strong elongate inner metatarsal tubercle with a free rounded tip anteriorly; a small prominent outer tubercle; inner metatarsal fold well defined, running back somewhat diagonally but not reaching heel; no outer fold; subarticular tubercles rather prominent; few or no distinct supernumerary tubercles on sole.

An indistinct dorsolateral fold; skin of dorsum covered with minute tubercles intermingled with slightly larger tubercles, many with brown, horny tips, the tubercles not in distinct rows; sides with one or two rows of somewhat larger tubercles; area on rump, dorsal surface of thighs, tibia and tarsus with somewhat larger tubercles, those on lower (anterior) face of tibia in longitudinal rows, while the others are in diagonal rows; chin and venter smooth, with deep brown glandular areas on sides of neck, on anterior part of venter extending slightly up on side behind axilla, and on posterior part of venter. A large gland on outer part of the posterior face of thigh, and one on posterior part of tibia.

Color: Brownish with a light-edged brown mark beginning midway between, and on eyelids, running back to the sacral region; an indistinct darker line from eye to groin becoming double posteriorly; tympanum dark; small brown spots on rump and on dorsal surface of legs; indistinct light flecks on outer part of posterior face of femur with two somewhat lighter regions below and lateral to vent; no dark ventral spots save for the horn brown of glandular areas.

Measurements in mm.: Snout to vent, 40; width of head, 16; length of head, 19; arm, 23; leg, 54; tibia, 16; tarsus and foot, 28.

Remarks: This species is believed to extend from Mexico to South America. There is some doubt that all the specimens referred in the literature to *melanonotus* actually belong to Hallowell's species. I have specimens, belonging to the form described, from Turrialba, and Bataan. What I believed to be this species was heard at Moravia but none was captured.

This species can be heard calling during the daytime as well as at night, and choruses occur day after day in swampy areas even when there is no evidence that the breeding season is on.

Leptodactylus quadrivittatus Cope

Leptodactylus quadrivittatus Cope, Proc. Amer. Philos. Soc., vol. 31, 1894, p. 339 (type locality, Buenos Aires, Costa Rica); Nieden, Das Tierreich, Lief. 46; Anura I, 1923, p. 477; Dunn, in Barbour, Ann. Rep. Barro Colorado Island. Biol. Lab. Panamá Canal Zone, 1931, p. ? ("Rio Tucumen");

Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 410, 418; Schmidt, Smithsonian Misc. Coll., vol. 89, 1933, No. 1, p. 5 (Panamá.)
Leptodactylus poecilochilus (*part.*) Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 106-107.

Diagnosis: Form slender lanceolate; nostril nearer eye than the median point on upper lip; heel to front of eye; two glandular ridges on each side of the vertebral line; vomerine teeth in arched series extending to level of outer edge of choana, and closely approximated to the median line; tympanum oval, its long diameter equals two thirds length of eye.

Description of species: Body lanceolate; head slender, the muzzle narrow and prominent; canthus lacking; nostril nearer eye than tip of snout, but separated from eye by a distance greater than length of eye; tympanum vertically oval, its greatest diameter two thirds diameter of the eye; interorbital distance greater than an eyelid; some glandular warts about scapular region. Choanae large, about as long as the ostia pharyngea; vomerine teeth behind choanae in two arched series that extend outward to outer level of choanae, narrowly separated mesially; tongue forming a wide longitudinal oval, openly notched behind.

Arm moderate, the leg relatively short, the heel reaching only to the anterior edge of eye; tips of digits not widened, the subarticular tubercles well developed; a distinct oval inner metatarsal tubercle.

Skin smooth with two stout glandular ridges running along back on either side of the median line; a discoidal abdominal fold.

"The ground color above and on the sides is gray, which is marked above with four longitudinal black bands. The two median of these are wider and commence at the end of the muzzle, and extend to the extremity of the urostyle. They expand above and over the eyelids. The lateral bands commence narrow at the orbits, and widen on the sides, extending to the groin. The median dorsal band of the ground color is paler than the rest of the ground, and has a pinkish tinge, which is probably more distinct in life judging from traces of pink near the orbit. The side of the head is black to and including the tympanic disc, excepting a pale stripe which passes below the eye to the lower border of the tympanic disc. It is crossed by two or three black lines which descend from the eye to the black lip. A pale crescent in front of tympanic disc. A pale line extends upwards and forwards from the groin on the side. The limbs are all cross-banded, except the tibia whose upper surface displays an irregular wide longtitudinal band, which is a marked peculiarity. Posterior face of femur bounded below by a

pale line, which is bordered above by a brown band. Tibia unicolored, foot brown, below." Data from type description.

Measurements in mm.: Snout to vent, 37; snout to posterior edge of tympanum, 14; width of head, 15; arm from axilla, 18; hand, 8; leg, 65; foot, 31; tarsus, 12.

Remarks: This species is presumably a lowland form. I have not recognized the species in the material at hand.

Leptodactylus maculilabris Boulenger

Figure 13

Leptodactylus maculilabris Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, pp. 404-405 (type locality Costa Rica. C. F. Underwood coll.); Nieden, Das Tierreich, Lief. 46; Anura I, 1923, p. 476.
Leptodactylus poecilochilus (*part.*) Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 106-107.

Diagnosis: Snout as long as eye, nostril nearer tip of snout than eye; interorbital space equals width of an eyelid; tympanum two thirds eye diameter; first finger longer than second; digits without fringe; a tarsal fold; heel to midway between eye and snout tip.

Description of species: (From type description). Snout rounded, scarcely prominent, as long as the diameter of the orbit; nostril nearer the tip of the snout than eye; interorbital space as broad as the upper eyelid; tympanum very distinct, nearly two thirds diameter of eye.

Tongue oval, slightly nicked behind. Vomerine teeth in two slightly curved series behind choanae, narrowly separated mesially, extending outwards as far as the outer border of choanae.

Fingers moderate, first much longer than second; toes slender not fringed; subarticular tubercles strong; sole smooth with a small, oval, inner metatarsal tubercle; a tarsal fold; tibiotarsal articulation reaches midway between eye and end of snout.

Skin smooth; a glandular fold on each side of the back from eye to groin; another from eye to shoulder; a discoidal ventral disc.

Color: Pale brown above, glandular folds black-edged; a dark brown triangular blotch on the back of the head, the base between the eyes, the apex between the shoulders; sides of head whitish, with a black canthal streak, and three dark brown spots on the tip, the second extending to the eye; sides of limbs with large dark brown spots; a white dark-edged streak along the back of the thighs; uniform white beneath.

Measurements: Snout to vent 43 mm.

Remarks: Known from a single specimen.

The specimen that I am describing is from Los Diamantes, near Guápiles, Costa Rica.

Diagnosis: (RCT. No. 2476.) A small species (43 mm. ♀, 35 mm. ♂) with the venter nearly uniform flesh-white below, with very fine powdering of pigment on chin and breast; above pale brown with or without the black edging on the dorsolateral glandular ridges; tympanum length three-fourths eye length; heel to

FIG. 13. *Leptodactylus maculilabris* Boulenger. R.C.T. No. 2476; Los Diamantes, Costa Rica. Snout-to-vent length, 35 mm.

front of eye; a few enlarged lateral tubercles or pustules in a more or less linear diagonal row; first finger at least slightly longer than second; first finger of males with two lateral spines; vomerine teeth in transverse elongate series.

Description of the species: Head rather narrow oval, its greatest width (12 mm.) less than length (13 mm.); snout projecting slightly (.8 mm.) beyond lip; tympanum large, longer than high, its length (3 mm.) equal to three fourths eye length (4 mm.); the distance

between tympanum and eye more than half greatest diameter of tympanum; eye length less than length of snout (5.3 mm.); width of an eyelid (3 mm.) approximately equal to the interorbital interval (2.96 mm.); canthus indicated, rounding somewhat; a distinct concavity in loreal region behind nostril; a strongly defined supratympanic fold beginning below corner of eye, covering upper edge of tympanum and then curving down to near arm insertion; groove from lower jaw borders tympanum; a distinct glandular area in front of arm insertion but no specific tubercle.

Choanae small, widely separated, the diameter of one is contained in distance between, four times; vomerine teeth in two transversely elongate fasciculi, the tooth-rows considerably behind posterior level of choanae on a level with the transverse palatine ridge, extending out to near the level of the middle of choanae; ten to twelve teeth in each fasciculus, the two very narrowly separated mesially; palatal glands opening in a short straight palatal groove a little closer to level of choanae than to the front of palate; vocal slits elongate, the slits opening very near the jaw; tongue nearly as wide as long, notched behind.

Arm short, the wrist failing to reach the tip of snout; no tubercles below elbow; no evidence of a ridge or tubercles on under side of arm; first finger thicker at base, and somewhat longer than second; first finger bearing a pair of spines (at this time naked not covered with horn, the normal horny covering probably lost accidentally or shed); the digits slightly thickened at tips with slight ridges on inner side of second and third digits; subarticular tubercles six, somewhat rounded; no supernumerary tubercles on hand; inner metacarpal tubercle rather large, elongate, the proximal spine arising from its side; outer (palmar) tubercle large, somewhat bifid.

Leg short, the heels fail to overlap when legs are folded; heel to front of eye; a well-defined tarsal ridge somewhat diagonally placed more than two thirds of the length of the tarsus; no trace of an outer fold; toes with a vague web remnant and distinct skin fringes to small terminal discs; subarticular tubercles strong; no supernumerary tubercles; under surface of foot and tarsus with minute spinose granulations unequally distributed; an elongate inner metatarsal tubercle, a slightly smaller outer.

Skin on head and anterior part of back, smooth (under a lens fine corrugation is discernible); dorsolateral glandular ridge indefinite; a series of somewhat pustular glandules on posterior part of sides; some fine spiny glandules on rump and upper surface of

thigh and tibia; glandular areas in front of arm insertion in postaxillary region extending on to breast on back of tibia and thigh.

Color: Light brownish above, with a triangular dark mark crossing head and eyelid, the apex on shoulders; somewhat lighter band in front of triangular spot; dorsolateral folds more or less edged with darker; sides lighter; venter flesh-white with some powdering of pigment on chin and breast, much less on abdomen; indefinite spotting on legs and posterior side of tarsus; back of thighs reticulated with brown and dull white; an elongate dark-edged light spot on outer part; darker under hands and feet.

Measurements in mm: Snout to vent, 35; width of head, 12; length of head, 13; eye length, 4; tympanum, 3 x 2.4; arm, 19.5; hand, 8.6; leg, 54; tibia, 16.6; foot and tarsus, 27.7.

Remarks: I have examined other specimens of this species from Los Diamantes and Turrialba. The smaller specimens have no trace of pigment of venter.

Genus EUPEMPHIX Steindachner

Eupemphix Steindachner, Sitzungsb. k. Akad. Wiss. Math.-natur. Cl. Wien, vol. 48, 1863, p. 188.

Type of genus: *Eupemphix nattereri* Steindachner.

A single diminutive species, long treated under the genus *Engystomops*, presumably occurs in Costa Rica, since its range is said to extend from Veracruz in Mexico to Venezuela.

Eupemphix pustulosus (Cope)

Paludicola pustulosa Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 15, Aug., 1864, p. 180 (type locality, New Granada, on the River Truando, W. S. Wood, coll.).

Microphryne pustulosa Cope, Journ. Acad. Nat. Sci. Philadelphia, N.S. vol. 8, pt. 2, p. 155; Proc. Amer. Philos. Soc., vol. 18, 1879, p. 267 (Tehuantepec).

Microphryne (*Paludicola*) *pustulosa* Sumichrast, Bull. Soc. Zool. France, vol. 5, 1880, p. 189 (Habits; Tapaná, Oaxaca).

Engystomops pustulosus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 275 (Tehuantepec, Mexico); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1901, p. 242 (Tehuantepec); Ruthven, Zool. Jahrb., vol. 32, 1912, pp. 300, 308-309 (color and habits; Cuatotolapam, Veracruz); Kellogg, U. S. Nat. Mus. Bull., No. 160, 1932, pp. 76, 77-81 (Cosolapa, Santo Domingo and Tehuantepec in Oaxaca).

Bufo (*Microphryne*) *pustulosus* Peters, Monatsb. Akad. Wiss. Berlin, 1873, p. 616 (Chiriquí); Brocchi, Études des batraciens de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, pt. 3, sect. 2, livr. 2, 1882, p. 86, pl. 8, figs. 1, 1a-1d.

Eupemphix pustulosa Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 1, 1888, p. 188; Nieden, Das Tierreich, Lief. 46, Amphibia, Anura I, 1923, p. 165, fig. 215 (Mexico to Venezuela); Noble, New York Acad. Sci., vol. 30, Oct. 31, 1927, pp. 87, 88 (life history).

Diagnosis: A diminutive toadlike species reaching a length of about 30 mm.; no vomerine teeth; no maxillary teeth. Choanae partly concealed by overhanging jaw; vocal sacs and a large external subgular vocal sac.

Description of species: Body squat, toadlike; head small, snout short subacuminate; eye large, its length equal to its distance from the tip of snout; nostril nearer to median point on lip than to eye; tympanum small (more or less concealed by skin in most specimens); parotoid gland large, subtriangular, lying behind tympanum; width of interorbital space equals distance of nostril to eye, greater than width of upper eyelid; canthus rounded, loreal region vertical or but slightly sloping to lip.

Tongue small, not notched or emarginate behind; choanae large partly concealed by overhanging palatal shelf; a large subgular vocal sac, vocal slits present in mouth; no vomerine or maxillary teeth.

Skin above very rough, granular and wartlike the larger pustules complex composed of a granule surmounted by a small spine and surrounded by other granules often in rosette form; the roughened areas extend out to limbs; ventral surfaces smooth, somewhat areolate or finely granular; often a diamond-shaped or an inverted-V-shaped area on back outlined by small tubercles or short folds; tubercles on side usually large; a pair of especially enlarged parotoidlike glandular tubercles on side; frequently a skin fold across breast, prominent in males; one or more prominent tubercles at corner of mouth; ventral and posterior part of thigh granular. Usually a series of glandular tubercles about anus.

Limbs rather short; fingers slender, free from web, first not extending beyond the second; no subarticular tubercle on penultimate finger joint; supernumerary tubercles on palm; two large palmar callosities or tubercles.

Third toe much longer than fifth; an elongate inner and a small outer metatarsal tubercle; none or but a very low tarsal fold, terminating in a prominent conical tubercle; tips of digits somewhat flattened, but not or negligibly widened; only a trace of a web with a fringe indicated on edge of digits; supernumerary tubercles on soles; heel reaches to parotoid gland or eye; when legs are folded at right angles to body, heels touch or are slightly separated.

Color in life: General color above ash-gray, with regular or irregular blotches of darker color; warts usually reddish or orange on anterior part of body, darker on posterior parts; a small orange spot on back between shoulders which is usually enclosed by an inverted

V-shaped black spot or a diamond-shaped black spot; an interorbital bar usually present; a narrow median line in sacral region cream or orange in color; lateral parotoid usually yellow or orange in definite contrast to ground color (easily observed in preserved specimens); granules on mouth angle cream; a large white area usually present on arm, with a dark bar crossing the forearm; hind leg barred with black forming a continuous pattern when leg is folded; folds formed by vocal sac blackish; breast dark, with black abdominal spots on a dirty white ventral coloration.

Measurements in mm.: (EHT-HMS No. 2308 largest specimen.) Snout to vent, 30.2; length of head, 8; width of head, 8.1; arm, 19; leg, 35.5; tibia, 11; foot and tarsus, 16.5.

Remarks: I have not found the species in Costa Rica, but it is included in the fauna since it occurs both north and south of this country. In Mexico no constant variations have been observed in the various populations examined, save that the northern specimens are almost invariably more rugose than specimens from farther south. The lateral gland is almost universally present. The secretion has the same yellow appearance as that from the parotoid on the neck.

Specimens were found in the savannah areas in Veracruz, usually about small pools in the evening or at night. The call is a chirp of a rather deep pitch and with the quality of the call of a dove. Two or three floating "nests" containing eggs were found, which seemingly belonged to this species. At Tierra Colorado in Veracruz the specimens were found around pools in the forest. In Chiapas specimens were found at night along the railroad, calling from the banks of small pools.

They range from central Veracruz throughout Central America to Venezuela. I have not examined specimens from Costa Rica.

Genus MICROBATRACHYLUS Taylor

Type of the genus: *Microbatrachylus hobartsmithi* Taylor.

Species of this genus have a strong sexual dimorphism in the size of the tympanum. Males lack the vocal slits and sac, but have a tympanum whose diameter often equals the length of the eye. A distinct inguinal gland is present in both sexes, the individual glandules visible under a lens. The gland is usually proportionally largest in the more diminutive species, often reaching the size of the tympanum, or rarely the size of the eye. All of the known species are small or diminutive and in Costa Rica the males vary between 15-25 mm. in length, the females 18-30 mm.

Many of the Mexican forms of the genus have no or only a trace of vomerine teeth, while others have them rather well developed. All of the Costa Rican forms known have vomerine teeth developed to a greater or lesser extent. The ventral disc is not especially pronounced, but usually lateral folds are present on the venter that extend back to the median point of the thighs and do not connect to form a discoidal fold some distance in front of the thigh as is typical of the species of *Eleutherodactylus*.

This seems to be due to a subcutaneous membrane that runs transversely and connects the skin to the muscles of the abdomen. In *Microbatrachylus* the membranes, if present, follow the lateral disc-folds to the thighs and are nearly longitudinal instead of transverse in position. In all the species the subarticular, supernumerary, metatarsal and metacarpal tubercles are especially well developed. The finger-discs are absent or smaller than toe-discs and many forms have at least certain of the discs asymmetrical.

Careful collecting in Guatemala, Honduras, and Nicaragua will doubtless prove the presence of species of this genus in the territory intervening between Mexico and Central America. One may also expect to find the species extending into territory south of Costa Rica and into South America.

KEY TO COSTA RICAN SPECIES OF MICROBATRACHYLUS

1. Skin with several longitudinal folds, the outer ones tending to be parallel (six to eight folds usually indicated). Heel reaches beyond eye, often half way to nostril; tympanum of male never equal to eye length ..... 2.
   Skin folds partially parallel; heel reaching a variable distance; diameter of tympanum of male often reaching eye length or more 3
2. Chin, breast and venter more or less heavily pigmented; first and second fingers of near same length, but the first usually largest; body heavier; inguinal gland smaller; length in mm. 27.5 ♀, 22.5 ♂ ..... *polyptychus*
   Chin (except for outer edge), breast and venter nearly pure white; second finger a little longer than first; body slenderer; inguinal gland larger; length in mm. 23 ♀, 17.2 ♂ ..... *rearki*
3. Larger species (25-30 mm. ♀); females without a distinct pair of dorsal folds running forward to shoulders, where narrowly separated they suddenly diverge towards eyelids; toes not strongly pointed; discs not conspicuously asymmetrical 4
   Smaller species (17-21 mm. ♀; males 13-14 mm.) with a pair of folds diverging from shoulders to eyelids; digital tips pointed; middle toe-discs strongly asymmetrical 5
4. Large form (30 mm. ♀, 23 mm. ♂); a pair of somewhat symmetrical, curved folds on shoulders, widely separated; other

folds broken into a large number of elongate tubercles or short ridges; a more or less distinct lighter (often bluish-white), chevron-shaped band just back of shoulder region; teeth in oblique groups; leg longer, the heel reaching between eye and nostril; finger discs not wider than digits; abdomen more or less granular, often strongly so ..... *underwoodi*

Length 25.5 (sex ?); a chevron-shaped mark may be present on shoulders; skin of back "thrown into delicate longitudinal parallel folds which are easily lost"; abdomen smooth; heel reaches orbit ..... [*bransfordii*]

5. Somewhat larger; folds on back not forming an hourglass figure. Chin heavily pigmented, venter cream; broad, triangular, blackish mark covers vent and back of thighs, cut by a narrow transverse cream stripe; length 21 mm. ..... *stejnegerianus*

Smaller form, venter not cream colored or white, but pigmented; the granules sometimes lighter. Venter strongly granular; less than 20 mm. in length 6

6. Chin smooth; the folds on back often forming an hourglass figure; a straight fold continues back from the tympanic fold; body and limbs granular and tubercular; head moderately smooth; inguinal gland often whitish; outer metatarsal tubercle half size inner; 18.3 mm. ♀, 23 mm. ♂ ..... *persimilis*

Venter smooth; dorsum nearly smooth; outer metatarsul tubercle nearly as large as inner; folds on back not forming an hourglass-shaped figure; four small black spots on back; 17 mm. ♀ ..... *costaricensis.*

Microbatrachylus underwoodi (Boulenger)

Figure 14

Hylodes underwoodi Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 18, p. 340 (type locality, La Palma, Costa Rica, 1600 m. elev. Underwood coll.) Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug. 1900, p. 229, pl. 66, fig. D. Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 435-436.

Diagnosis: A small frog, maximum length for females 30 mm. males approximately 23 mm.; no distinctly widened discs on fingers, very small discs on toes; no web between digits; first and second fingers of very nearly equal length; venter granular; very strong subarticular tubercles; supernumerary tubercles on digits as well as on palm and sole; an elongate tarsal fold often discontinuous; an elongate, cream-colored gland between tympanum and arm; tympanum of female one half of eye length, of male, diameter usually equal to eye length; a small inguinal gland; vomerine teeth present.

Description of species: (K.U.M.N.H. No. 24872, Isla Bonita, Volcán Poás, eastern slope 5600 ft. elev.). Body rather heavy, head oval; the canthus distinct; loreal region slightly concave, the sides sloping obliquely to lip, part above lip granular; length of

snout 4.4 mm.; diameter of eye (3.3 mm.) a little greater than distance between eye and nostril; internarial distance (3.9 mm.) equals the interorbital width, slightly greater than width of an eyelid (3.8 mm.); latter with numerous tubercles and a lateral ridge, usually continuous with supratympanic ridge or fold that tends to run back sending down an indistinct branch behind tympanum; a pair of elongate tubercles between tympanum and arm insertion, usually

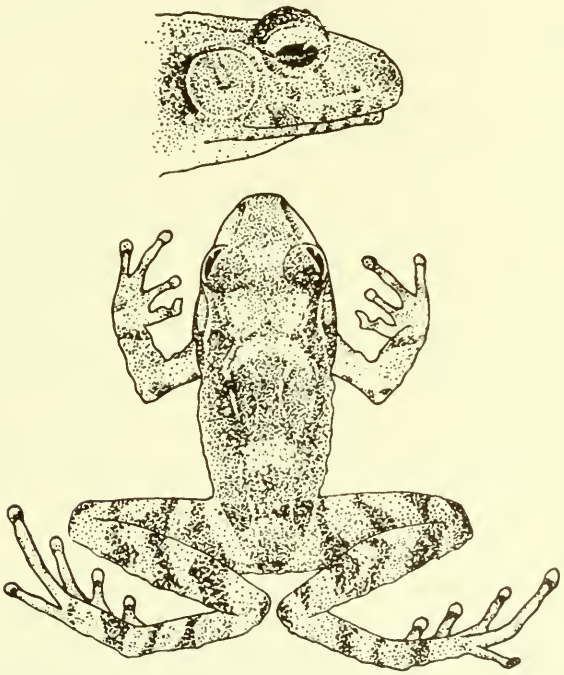

FIG. 14. *Microbatrachylus underwoodi* (Boulenger). K.U.M.N.H. No. 24828; Isla Bonita, Volcán Poás, Costa Rica; snout-to-vent length, approximately 29 mm. Head, much enlarged.

fused into a single cream-colored ridge; tympanum subcircular a little higher than long (2.5 × 2.2 mm.) the greatest diameter .65 percent of eye length. (In males the tympanum is longer than high and the greatest diameter is .9 of eye length or equal to it.)

Vomerine teeth in two transversely oval fasciculi, somewhat diagonally placed, extending out as far as inner level of choanae, and reaching back to transverse bony palatal ridges or a little behind them; teeth numerous (8-10), in somewhat curving series; palate slightly trough-shaped,—not on a single plane; choanae flair

out lateral to their anterior bony border; tongue irregularly oval, wider behind than in front, not emarginate, shaped somewhat like a grain of maize. (Males without vocal sac or vocal slits.)

Wrist reaches tip of snout; first and second fingers of equal length; tips of fingers slightly oval, scarcely wider than digits, the two outer fingers bearing a transverse terminal groove; subarticular tubercles very large, with six supernumerary tubercles on palm; two metacarpal tubercles, inner large, elevated oval a third length of first finger, outer subcircular elevated and distinctly single; a prominent tubercle on outer side of wrist; ventral and posterior surface of arm strongly tuberculate; fingers with lateral ridges indicated; tibiotarsal articulation reaching slightly beyond eye; toes with distinct small discs, those of the inner and outer toes smallest, the discs but little wider than digit, those of inner toes unequal in size slightly asymmetrical the largest wider than digit, measuring 1 mm. in width; subarticular tubercles large, subconical, strongly elevated anteriorly; numerous supernumerary tubercles on sole, even intercalated between subarticular tubercles (absent or scarcely indicated in some specimens); a low elongate inner tarsal fold; a row of rough tubercles on outer edge of tarsus; an elongate oval inner metatarsal tubercle, a smaller conical outer tubercle; dorsal surface of thigh strongly tubercular; under surface of tibia, front face and part of the posterior surface of thigh, and an area in groin shining smooth.

Skin of dorsal surface and lateral surfaces of body strongly tubercular or granular, the granules largest in postaxillary region; on back a more or less continuous skinfold begins at the back edge of eyelid, courses diagonally back onto the interscapular region then curves sharply outward for a short distance then continues back as a somewhat angular or sinuous fold along the dorsolateral region; at the point where the curve begins, a small curving branch is given off and runs forward a short distance, and near the middle of curve a branch begins and runs in and back parallel to its fellow; a hair-fine median fold present; some indistinct folds or rows of tubercles on sides of rump that may or may not connect with outer anterior fold; venter largely granular, while breast and chin are smooth; inguinal gland relatively small; ventral disc indistinct.

Color: Dark brown to blackish brown above, the marking indistinct unless submerged in water; a dark mark at tip of snout followed by a lighter area, then another spot of dark followed by a very narrow dim interorbital light mark; behind this a broad irregular interorbital dark spot; a broad W-shaped pattern bordering

occiput but extending behind it; following this is a transverse chevron-shaped or curving light mark (usually constant and easily observed in most specimens); behind this a large somewhat triangular median spot followed by a small spot; on upper sides of rump two somewhat triangular spots with a terminal spot connecting with the darker anal area. The ground color of back is olive, of sides yellowish olive; lip bearing four more or less distinct spots, two from eye separated by dull cream; tympanum dark, and a dark line following the supratympanic fold; anterior part of side dusky. In life the groin and inner anterior part of thigh pinkish to red (flesh in preservative); back of thigh dusky with a pinkish wash (brown in preservative), the tubercles on its lower edge whitish; chin in life lavender with a yellowish tinge on venter. (Sometimes the pinkish red areas are salmon, sometimes approaching magenta-pink); sole of foot purplish, larger tubercles on foot and hand pure white; some fine dusky flecks on chin; a peppering of pigment on ventral surfaces; legs spotted or barred with black.

Measurements in mm.: Snout to vent, 30; length of head, 11; width of head, 11.8; length of snout, 4.4; length of eye, 3.3; height and length of tympanum, 2.3 x 2.1; arm, 18; hand, 7; leg, 48; tibia; 16; foot and tarsus, 22.

Remarks: This species is one of the common forms in the collection. Specimens were taken at Turrialba, Picayas, Isla Bonita, Morehouse Finca, Moravia. More than a hundred specimens are at hand.

Microbatrachylus polyptychus (Cope)

Hylodes polyptychus Cope, Proc. Amer. Philos. Soc., vol. 23, 1886, p. 276 (type locality, Nicaragua, L. F. Bransford, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 15; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June and August 1900, pp. 228-229, pl. 66, fig. c. (Hda. Rosa de Jericho, Nicaragua and La Palma, Costa Rica); Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 15.

? *Eleutherodactylus polyptychus* Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, p. 161 (Monteverde and Guápiles); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, pp. 410, 418 (Barro Colorado Island).

Diagnosis: This diminutive form may be recognized by its small size (females 27.5, males 22.5), elongate dermal plicae six to eight in number on dorsal and dorsolateral regions; paired lateral lighter stripes or areas usually connecting with lighter coloration of groin and posterior part of side, granular belly, very small digital discs, with well-developed supernumerary tubercles on sole, palm, and tarsus. In life there may be some pinkish or pinkish lavender color in the stripes; no vocal sac; inguinal gland small; venter granular.

Description of species: (K.U.M.N.H. No. 24954 ♀, Isla Bonita, Volcán Poás, Costa Rica). Head rather narrower than body (female, gravid), snout a somewhat pointed oval; canthus distinct, the edge bearing a very low, indistinct ridge, (discernible under lens), which is continued as a much thickened ridgelike edge to upper eyelid, but not continuous with the supratympanic ridge or fold; length of eye (3.4 mm.) greater than distance to nostril (2.6 mm.) but shorter than snout (4 mm.); tympanum higher than wide (2 x 1.6 mm.), greatest diameter about .6 length of eye; tympanum rather high, reaching higher than corner of eye, so that supratympanic fold seems to begin on lower eyelid and curves up, over, and straight back, then curves slightly down for some distance on side as a tubercular fold; tympanum transparent with a median oval pigmented area entering from the top; an elongate glandular tubercle from tympanum to near arm insertion; loreal region sloping obliquely to lip, not or scarcely concave; snout flat with a slight irregular depression between nostrils; eyelid very rugose with two larger tubercles, marking beginning of a body skinfold; width of an eyelid (2.3 mm.) less than interorbital width (2.8 mm.); snout rather broad the width between nostrils 2.5 mm.; width of head (10.2 mm.) slightly less than length (11 mm.); choanae rather lateral, relatively small (larger on left side) with two large transversely diagonal fasciculi behind choanae and not quite reaching inner level; palatal area in front of choanae flares out over edge of choanae; tongue a pointed oval, rounded behind without emargination, free for less than one fourth of its length; (males definitely without vocal slits).

Wrist reaches a short distance beyond the tip of the snout; finger with the tips only minutely wider than digit, outer ones slightly pointed; six subarticular tubercles very large, six large supernumerary tubercles on palm with numerous minute tubercles intermixed; inner metacarpal tubercle strongly elevated; inner tubercle (palmar) large, biscuit-shaped; a row of pearl-tipped tubercles on under side of arm and numerous other small warts and tubercles elsewhere on arm.

Heel reaches halfway between nostril and eye; toes with discs larger than those on fingers, nearly symmetrically oval in shape; large conical subarticular tubercles; numerous supernumerary tubercles of large and small size on sole; a large elevated inner metatarsal tubercle less than one third length of first finger; outer tubercle smaller distinct; a fine inner metatarsal ridge, and scattered

tubercles on under surface of tarsus; no trace of web on hand or foot but some digits may show traces of lateral ridges; scattered minute tubercles on sides of head and dorsum; area about side of neck and anterior half of side of body with large regular granules; latter half of side and front face of thigh, most of posterior face of thigh, chin and breast extremely smooth; venter except on anterior and anteromedial parts with regular granules; posteroventral face of femur and area about vent, granular; back with a series of plicae, the most prominent beginning on orbits as tubercles, passing gradually mediad and posteriorly becoming parallel near middle of body; a faint suggestion of some flat ridges from snout to end of occiput and a median hair-fine ridge extending length of body; dorsolateral fold from eye to groin finely beaded posteriorly; fold from tympanum terminates on side, while above it is a short fold anterior to sacrum; large warts and tubercles behind tympanum and behind arm insertion; minute tubercles of dorsum also arranged more or less in longitudinal rows; above, thigh and tibia very rugose, the largest warts following the transverse darker lines.

Color: Lavender-brown from snout to rump with darker areas arranged as follows: a broad stripe from interorbital area to near back end of occiput in front of which snout is lighter; supraocular areas purplish black; a pair of stripes arising indistinctly at orbits, converge and at back of occiput widen considerably continuing back to sacrum; behind lighter sacral area, an irregular black spot and behind this two narrow lines connecting with the triangular dark area about vent; two elongate darker spots on upper part of side, one behind, one in front of sacrum; area from eye bordering the darker lavender brown, light lavender rose, growing less evident on sides and groin; side of head, neck, and an area on side, back of axilla, dark; a purplish black spot from tip along snout and loreal region separated at tip from its fellow by a vertical cream line; two other large black spots on lip, and some smaller irregular clouding and several indistinct cream spots on both lips; tympanum dark, the diagonal gland cream; limbs including foot barred with black, the heels clay-color above; ventral surface clouded on chin; venter with an indistinct reticulation of dusky; concealed surface of thigh nearly uniform light brown with sometimes a pinkish wash; a transverse cream line runs length of thigh on posterior surface; purplish under foot and palm.

Measurements in mm. of Microbatrachylus polyptychus

	K.U.M.N.H°		
	24958 ♀	24954 ♀	24953 ♂
Snout to vent	27.5	26.2	22.5
Length of snout	4.7	4.8	4
Length of eye	3.8	3.5	3.1
Diameter of tympanum	2.2	2	2.7
Width of head	11.1	10	9
Length of head	12	11	10
Arm	16	15.5	14
Hand	6	7	6.8
Leg	42.3	43	39
Tibia	14	14.5	12.3
Foot and tarsus	21	21	19

Remarks: Specimens were taken at Bataan, Turrialba and surroundings, at Isla Bonita on Volcán Poás, and at Moravia, a total of more than 30. The intensity of the pigmentation may vary in the general pattern of coloration and markings as described. There are three rather notable exceptions.

No. 24958 has a light stripe from the tip of the snout to end of body, narrowly interrupted on occiput, while the chin has more pigment and a longitudinal median light stripe. No. 24953 lacks the white line across the posterior surface of the thighs. These two are from Isla Bonita. One specimen No. 24959 (Turrialba) has the dorsal and posterior lateral surface clay-color, the side of head, neck, and anterior part of side, deep black; legs and arms deep black; chin purplish; venter lavender, clouded; heels clay.

Males differ from females in having a larger tympanum, in having a smaller size and a small nuptial pad on top of first finger. I find no trace of a vocal sac or vocal slits in males. The amount of granulation on the belly is variable, usually only the posterior portion of the venter, and the lateral edges show granulation. Both males and females from Turrialba and surroundings have heavier granulation on venter, covering a larger area, and there are probably greater dorsal rugosities, than in those from Isla Bonita. The inguinal gland is always present, but rarely conspicuous; most specimens have a much rougher skin than that described.

Microbatrachylus persimilis (Barbour)

Figure 15

Eleutherodactylus persimilis Barbour, Occ. Pap. Boston Soc. Nat. Hist., vol. 5, Jan. 30, 1926, p. 193, pl. 14 (type locality, Suretka, Costa Rica, near the boundary of Bocas del Toro Province, Panamá, Professor E. R. Dunn and Mr. Chester B. Duryea, colls.).

° All from Isla Bonita.

Diagnosis: A diminutive species (18 mm.), the surfaces largely covered with small rough tubercles; a pair of lines, formed of tubercles beginning behind eye tend to converge for some distance toward middle line then continue back parallel, close together for a very short distance; a very well-defined palmar tubercle; an inguinal gland present; discs of all digits rather pointed, that of third and fourth toes distinctly asymmetrical; vomerine teeth

FIG. 15. *Microbatrachylus persimilis* (Barbour). K. U. M.N.H. No. 28359. Morehouse Finca, approx. 4½ mi. S Turrialba, Costa Rica. Actual snout-to-vent length, 18 mm.

strongly developed, widely separated, much behind choanae; ostia pharyngea more than double size of choanae; tympanum of male as large as eye, smaller in females.

Description of species: (From type). Snout moderately pointed, the canthus rostralis distinct but slightly rounded, without a raised edge; area from occiput to tip of snout very flat but minutely corrugated and tubercled; area about nostrils swollen but little and there is no distinct depression between them; the line of the canthus

can be traced to tip of snout; a fold or ridge on outer edge of eyelid and one or more large tubercles or numerous granules on eyelid; loreal region not concave, sloping obliquely to lip, the lores and side of head as far back as jaw angle corrugated or granular; eye moderately large, (2.3 mm.) a little longer than its distance from nostril (2 mm.) but shorter than snout (3 mm.). Tympanum large, transparent amber in color, a little higher than wide, its vertical diameter (1.5 mm.) more than half of eye length, separated from eye by a distance of 1 mm.; a broad flat fold (or skin thickening) extends from eye above tympanum then curves abruptly down behind the tympanum and jaw angle; width of an eyelid (1.4 mm.) a little more than half of interorbital interval (2.5 mm.) distance between nostrils (1.8 mm.), the nostrils much closer to the median notch on upper lip than to eye.

Choanae rather small, only about a third size of Eustachian tube openings (ostia pharyngea); vomerine teeth in two large, widely separated fasciculi placed behind posterior level of choanae; tongue oval, free for one third its length.

Arm short the longest finger extending beyond tip of snout; inner metacarpal tubercle, rounded, strongly elevated, at base of first finger; a single large elevated palmar tubercle; digits distinctly pointed, only tip of third wider than digit; only the fourth with a terminal groove; very strongly developed subarticular tubercles with numerous strongly developed supernumerary tubercles on palm; no trace of web but indistinct lateral ridges on edges of some of the fingers.

Leg short, the heel reaching only to middle of eye; a small inner tarsal tubercle scarcely distinguishable from numerous large subtarsal tubercles; an outer tarsal series of four or five large warty tubercles in a row; a large inner metatarsal tubercle rounded and well elevated; outer metatarsal tubercle smaller, sharply conical; toes with small terminal pointed discs, those of the third and fourth largest and distinctly asymmetrical; terminal grooves present on all discs; subarticular tubercles conical pointing rather forward; numerous supernumerary tubercles on toes and sole; a row follows the outer edge of fourth toes onto tarsus; fifth toe tiny reaching base of disc of third finger; no web, or only a vestige between toes two and three.

Skin of back strongly granular; beginning near the posterior corner of the eye a linear series of tubercles (or continuous tubercular fold) that tend to converge toward the middle of the back;

near the median line they turn back narrowly separated, parallel, thickened where they tend to terminate (only a suggestion of a continuance from this point running back); from the supratympanic fold is a more or less distinct line of tubercles; between these and the terminus of the dorsal lines a short dorsolateral line continues back in sacral region; sides tubercular or granular; granules are irregular and unequal in size; chin and breast smooth or practically so; venter, under side of thigh and an area on each side of vent very strongly granular, the granules usually not contiguous; a smooth area on distal part of posterior face of thigh; a rather large flat, but inconspicuous inguinal gland; inguinal area and front face of thigh smooth; arms granular or tubercular; under side of tibia and top of foot smooth.

Color: Tan with an indistinct interorbital brown spot; brown or blackish spots on the terminal part of the dorsal rows of tubercles; anterior and posterior pair of diagonal spots on sides; a pair of brown or black spots on side of rump; under surface of foot and hand brown; a hair-fine median light line and a similar longitudinal line on under face of tarsus; vent followed by a dim groove; a large triangular blackish mark on back of thighs, the apex at vent; entire ventral surface finely pigmented; a dim narrow line on upper part of lores; a dark spot below eye; trace of a whitish longitudinal line on thighs; legs barred more or less distinctly; a strong mark on supratympanic fold.

Measurements in mm. of Microbatrachylus persimilis

Museum number	K.U.M.N.H. 28359 ♀	R.C.T. 543 ♀	R.C.T. 2608 ♂	R.C.T. 2607 ♂	M.C.Z. Type ♀
Snout to vent	18	18.3	13.5	14.6	17.5
Width of head	7	7	5.5	6.2	6.4
Length of head	7	7.2	5.8	6.6	7
Length of snout	3	3.2	2.3	2.7	3
Length of eye	2.15	2.2	2	2.1	2.3
Height of tympanum	1.7	1.4	1.8	1.8	....
Length of tympanum	1.4	1.1	1.95	2.1	1.5
Arm	9	8.9	7	8	8.5
Hand	3.5	3.3	2.3	3	3
Leg	24	24.2	20	22.6	22
Tibia	8.2	8.5	7	8	8.5
Foot and tarsus	11.3	11.8	9.2	10.2	11.8

Variation: There is little variation in the general habitus of these specimens. The males have a proportionally and actually larger tympanum than the females which is, in specimens at hand, longer

than high and practically as large as the eye. The males are somewhat rougher, the tubercles being proportionally higher.

R.C.T. No. 542 is a very dark blackish-brown specimen bearing somewhat diagonal cream spots in the dorsolateral area, beginning behind the level of arm insertion. The anal region has an intensely purplish-black triangular area while the area on each side of the apex is light flesh. The structural characters are the same as those in the type.

No. 28358 has a hair-fine median cream line and a small cream line cutting off the upper part of the black triangle in the anal region. The underside of foot and tarsus are purplish, the tubercles white.

The coloration of the living animals, taken at night were dusky flesh below and brownish to clay or gray above; one or two taken in daylight were brown to reddish brown above and flesh below. The feet were purplish on the soles.

In certain of the specimens the lines of tubercles from eyes may, after their mesial approximation, continue back, diverging somewhat; two whitish tubercles are usually present below the tympanum; males are without vocal sacs or vocal slits; a few tiny nuptial asperities are on the top of the base of the first finger. The whitish line on tibia may be absent.

Remarks: Our collections contain several specimens of this diminutive species. They were found in the region of Turrialba chiefly in the low forest along the Río Reventazón. They were usually found hopping about on the forest floor, sometimes in the day, sometimes at night.

The transparency of the large tympanum and the very large ostia pharyngea permit one to discern light through the buccal region from tympanum to tympanum. The inguinal gland is occasionally present in *Eleutherodactylus* but usually it is very inconspicuous. Here it is relatively large, and forms a bright yellowish white spot as large or larger than the tympanum, and is close to the angle formed by thigh with the body.

[*Microbatrachylus bransfordii* (Cope)]

Lithodytes bransfordii Cope, Proc. Amer. Philos. Soc., vol. 23, Apr., 1886, pp. 274-275 (type locality, "Nicaragua," Dr. J. F. Bransford, coll.).
?Eleutherodactylus bransfordi Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, p. 161 (Orotino, Guápiles and Zent in Costa Rica).

Diagnosis: Small frogs, the heels reach to orbit; teeth in rows in two approximating groups, transverse or slightly arched, extending

out to near level of middle choanae; tympanum, in male, equals eye, in female smaller; canthus distinct, nearly straight; back with longitudinal folds easily lost. Length 25.5 mm.

Description of species: (From Cope *loc. cit.*). "Represented by a number of individuals of small size, but which are adult. The characters are well marked. The legs are short, the posterior when extended only bringing the heel to the orbit. The vomerine teeth are in two transverse or slightly arched series, near together well behind the line of the posterior nares, and not extending exterior to the middle of the latter. The tympanic disc is large, in four of the specimens equaling the diameter of the eye-fissure, in three others not exceeding two thirds of that size. The muzzle does not project, and is slightly truncate, and is about equal in length of the diameter of the orbit. The nostril is nearly terminal, lateral. Canthus rostralis distinct, obtuse, nearly straight. The toes are entirely free, and the dilations moderate. Two metatarsal tubercles, the inner larger. The skin of the back is thrown into delicate longitudinal parallel folds, which are easily lost."

Measurements in mm.: Length of head and body, 25.5; length of anterior limb, 13; of posterior limb from groin, 36; of foot, 17; of tarsus, 7.5; of tibia, 12.

Color: "In the color there is much pink on the upper and concealed surfaces. There are two dark spots on the lip, one below each canthus of the eye. There is a large more or less obsolete spot behind and above the axilla, with an oblique posterior border. There is a dark spot on the parietal region and generally one between the anterior parts of the orbits. There is generally a light open chevron pointing forwards across the middle of the back, with a dark one on front of it. In the largest specimen a pink band extends from the orbit posteriorly to the ilium. Posterior face of femur brown with light specks or finely brown mottled. Other lower surfaces whitish, except that in a few specimens the gular region is obscurely brown mottled.

Remarks: "This species belongs to the short legged group represented by the *L. diastema,* and need not therefore be compared with the *L. podiciferus, muricinus* and *rhodopis,* where the heel reaches much beyond the muzzle. From *L. diastema* it differs in the much longer posterior foot, and in the close approximation of its teeth, which form a row and not a fascicle. The tympanum is at all times much larger and more distinct, although it is variable in diameter.

"This species is dedicated to Doctor John F. Bransford, U.S.N., whose researches have thrown much light on the fauna of Nicaragua." (From Cope.)

Microbatrachylus stejnegerianus (Cope)

Hylodes stejnegerianus Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 338-339 (type locality, Palmar, Costa Rica, G. K. Cherrie coll.).

Diagnosis: Head flat; canthus distinct concave; tympanum round, diameter practically equals eye; dorsum with folds, and tuberculations between folds. Heel to orbit; digital discs small; limbs pink with dark cross bands; dorsum bistre brown with a pinkish area from eye to sacrum above tympanum. 15 mm. ♂, 21 mm. ♀.

Description of type: Muzzle flat, canthus rostralis distinct, concave, extremely little prominent. Nostril near the extremity and as far anterior to the eye as the long diameter of the eye slit. This latter dimension equals the diameter of the nearly round tympanic membrane. Integument of head smooth; that of back with a delicate median fold, and a fold on each side which diverges at the scapular region and extends to the orbit. Parallel to the latero-dorsal fold is a dorsolateral fold on each side which terminates anteriorly near to the oblique fold just mentioned. Between these folds the integument is tubercular. Sides and belly roughened with small tubercles; breast and throat smooth. Tongue longer than wide, pyriform, scarcely notched. Vomerine teeth in two fascicles well behind the choanae, and farther apart than each one is within the longitudinal line of the internal border of the nares. The heel of the extended hind limb reaches the anterior border of the orbit. Width of head 2.3 times in length of head and body. Digital enlargements small.

Colors: Above a dark bistre brown, with a pink band extending on each side from the eye to the sacrum, passing above the tympanic membrane. Posterior limbs blackish brown, except the inferior side of the femora, which are a lighter brown. Fore limbs pink with brown cross-bands. Belly dirty white, the breast and throat densely dusted with brown. Head uniform blackish brown, with the exception that on the edge of the upper lip there are three pairs of pale vertical bars which represent the borders of three lip-spots.

Measurements in mm.: Length of head and body, 15; length of head at posterior border of tympana, 5.5; width of head at posterior border of tympana, 5.5; length of fore limb, 11; length of fore foot, 2.5; length of hind limb, 24.5; length of hind foot, 11; length of tarsus, 4.5.

Remarks: It is only necessary to compare this species with the *H. polyptychus* Cope (*Proceeds. Amer. Philos. Soc.*, 1885, p. 276) from Nicaragua. In this species the top of the head and especially the eyelids are tubercular, while they are smooth in the *H. stejnegerianus,* and the integument generally is covered with larger and more numerous warts. The muzzle is shorter and wider, and the tympanic disc is only two-thirds the eye diameter. Finally, the series of vomerine teeth are more transversely extended.

This species is dedicated to Dr. Leonard Stejneger, the distinguished zoologist now in charge of the herpetological department of the U. S. National Museum, Washington. It is from Palmar; coll. No. 295. (From Cope.)

Remarks: I have a single specimen of this species taken at San Isidro El General on the Pacific slope, some thirty miles north of the type locality. The specimen is a female and in consequence differs from the male in the character of the tympanum, which instead of having its diameter equal to eye length, is only approximately two thirds of the diameter of the eye.

The following characters also obtain in this specimen (R.C.T. 1035): head flat smooth, eyelid with tubercles; canthus rounded, the loreal region somewhat concave behind nostril; snout barely projecting beyond the mouth; diameter of eye slightly longer than its distance to nostril; tympanum 1.8 mm. long, 1.95 mm. high; the general arrangement on the skin folds or ridges on dorsum the same as in type; width of an eyelid equal to interorbital width; edge of eyelid continuous with canthal line but not continuous with a thickened but very indistinct fold above tympanum, bending down behind it, and followed by a very indistinct fold to above arm, from upper tympanic level; side of snout dark continuing back across upper two thirds of tympanum diagonally to venter at a point somewhat behind arm insertion; behind this diagonal line, side light yellow or pink; two tubercles between tympanum and arm insertion; inguinal gland somewhat diffuse, difficult to discern, amber in color; a small inner tarsal ridge, and an outer also present, more or less distinct; fasciculi of vomerine teeth elevated considerably behind choanae, separated from choanae and from each other by a distance equal to transverse length of one fasciculus; a ridge running forward from fasciculus almost reaches choanae; area of choanal openings about half that of the ostia pharyngea; tongue abnormally flattened, sides nearly parallel, barely notched behind, free for less than one fourth its length; no vocal sac or slits; fingers without distinct discs, rather pointed; toes with small pads very

slightly pointed and somewhat asymmetrical; subarticular tubercles and supernumerary tubercles strong; a large, oval, elevated palmar tubercle; a smaller inner metacarpal tubercle; first and second fingers approximately equal in length; subarticular tubercles on toes strong; no webs; supernumerary tubercles distinct but smaller than on hands; heel to middle of eye; two metatarsal tubercles outer relatively large.

Color: Much as in the type but the stripe from eye to groin less distinct; black behind thigh is cut with a transverse light line and the black triangle above vent is cut by a vertical light line; venter dirty white; the chin, throat and front of breast strongly dusted with brown.

Measurements in mm.: (R.C.T. 1035, San Isidro El General). Snout to vent, 21; head length to jaw angle, 8.9; head width, 7.9; eye length, 2.9; eye to nostril, 2.35; nostril to median notch of lip, 1.6; arm, 12.6; leg, 31.2; tibia, 10; foot and tarsus, 14.

Remarks: Such differences as obtain are I believe largely due to the difference in sex.

Microbatrachylus rearki sp. nov.

Figure 16

Type: K.U.M.N.H. No. 31533, Bataan, Costa Rica, July 25, 1951; Edward H. Taylor coll.

Paratypes: K.U.M.N.H. Nos. 31540-31543, Los Diamantes, 1 mi. S Guápiles; Nos. 30909-30910, 31539-31540, 31544-31546, 30909-30911, 30913, Turrialba; 30912, 31534-31538, Bataan, Costa Rica. R.C.T. Nos. 589, 590, 590a, 590b, Turrialba, C. R.; 1471, 2898, Los Diamantes, C. R.

Diagnosis: A small species (23 mm.) with two irregular, broken dermal, median folds, and three lateral folds on each side; a large inguinal gland nearly area of tympanum; vomerine teeth present; heel to about half way between eye and nostril; diameter of tympanum in female half, in male more than three fourths length of eye; first and second fingers equal or second usually slightly longer; brown or blackish brown above; paper-white below; venter and median ventral part of thighs without pigment; gular region white or finely peppered with black pigment; small but distinct terminal pads, slightly oval or pointed, but only inner toes slightly asymmetrical.

Description of type: Adult female (23 mm.). Head ovally pointed, not as wide as body; canthus rounded, nearly straght; top of head and snout nearly flat, finely roughened (under lens) but

no tubercles or granules; eyelid with tubercles or flat pustules; tympanum subcircular, semitransparent, partially pigmented; greatest diameter of tympanum (1.6 mm.), slightly less than half of eye length, (3 mm.); distance of eye from nostril, 2.2 mm.; length of snout, 3.65 mm.; distance between eye and tympanum about 1.2 mm.; width of an eyelid, (2 mm.), less than interorbital interval

FIG. 16. *Microbatrachylus rearki* sp. nov. paratype. R.C.T. No. 589, Turrialba, Costa Rica. Actual snout-to-vent length, 23 mm.

(2.3 mm.); tip of snout reaches 1 mm. beyond lip; choanae moderate, lateral; vomerine teeth in a small fasciculus (abnormally absent on right side), slightly diagonal, much behind but within inner level of choanae; choanae smaller than ostia pharyngea; tongue distorted in type (in paratype shaped like a grain of maize, longer than wide, wider behind than in front, unemarginate behind free for nearly half its length); (no sac or vocal slits in male).

Arm small the wrist reaching beyond tip of snout; tips of fingers with a small but distinct terminal widening; a large somewhat oval palmar tubercle, a smaller inner metacarpal tubercle; subarticular tubercles and supernumerary tubercles distinct, large; a median ventral row of tubercles under arm; second finger a little longer than first.

Legs not especially short the heel reaching to nearly halfway between the eye and nostril; toe discs distinctly larger than those on fingers; a short inner metatarsal ridge on distal half of the tarsus,

a few indistinct tubercles mark the outer, with some other small granules on the ventral surface; two metatarsal tubercles, inner not more than twice size of outer; subarticular tubercles as large or larger than those on fingers, more elevated, pigmented instead of white as are those on hand; supernumerary tubercles small distinct; when legs are folded the heels overlap one or two millimeters.

Head generally smooth, eyelids tubercular or pustular; skin of dorsum with ridges and folds; a very fine median ridge from snout indistinct except posteriorly; a pair of somewhat irregular median ridges indistinct on occiput but continuing on to rump posteriorly; a pair of ridges from behind eye, converge gradually for some distance where they are interrupted and then continue back on each side to sacrum or beyond; outside of these are two folds on each side beginning behind shoulders but traceable forward more or less as rows of tubercles. Space between ridges, rump, sides of body, most of venter, underside and median posterior part of thighs granular or tubercular; chin, throat, breast, median anterior part of abdomen, front face of thighs and groin shining smooth.

Color: Above variegated blackish brown with a darker area or bar between eyes, the edges sharply defined in front, with a lighter gray bar in front of black; snout somewhat grayish with two darker median areas; loreal region slightly concave blackish to edge of lip, with a few light lip flecks; tympanum brownish with an indefinite darker area across top and continued diagonally downward somewhat; line of cream tubercles from tympanum to arm; latter light on the upper part, partly white underneath; a large lateral dark area on side behind arm followed by two or three dim diagonal darker bars separated by dim lighter areas; inguinal gland cream; groin whitish or pinkish; front and under part of thigh pinkish, abdomen and chin paper-white; some pigment on chin, none on venter; small triangular dark area about vent; remainder of posterior part of thighs somewhat brownish or pinkish; legs brownish indistinctly barred with darker, the tubercles not or scarcely larger where bars cross.

Measurements of the types and paratypes of Microbatrachylus rearki sp. nov.

Museum number	K.U.M.N.H. 30910	K.U.M.N.H. 31533	K.U.M.N.H. 30913	K.U.M.N.H. 31539	R.C.T. 2484	K.U.M.N.H. 30909	K.U.M.N.H. 30911
	♀	♀	♀	♀	♀	♀	♂
Snout to vent	23	23	22	21.5	20.2	19.2	17.2
Width of head	8	8.2	8	8	7.9	7.9	5.1
Length of head	9	9.2	9	8.8	8.2	8.1	7.5
Length of eye	2.9	3	2.9	2.55	2.7	2.5	2.2
Diameter of tympanum	1.55	1.6	1.4	1.4	1.3	1.4	1.8
Interorbital width	2.2	2.2	2.4	2.1	2.05	2.1	1.8
Width of eyelid	2	2	1.8	1.8	1.8	1.65	1.65
Length of snout	3.3	3.6	3.3	3	3	3	2.7
Arm	13	14.1	14.1	13.2	12	12.3	11
Hand	5	5.2	5	5	4.3	4.8	4.1
Leg	33.3	37	35	35	31	33	28
Tibia	11.2	12	15	11.2	10	10.5	9
Foot and tarsus	15	18	15	15.3	15	15	13

Remarks: The paratype shown in Fig. 16 is from Turrialba, Costa Rica. The outer folds are without dark color and scarcely discernible in the drawing. There is, however, no essential difference in the pattern of the folds and under a lens all of the folds can be discerned. The ridges and tubercles on the legs are less pronounced in the type.

There is considerable variation in the details of coloration, but general pattern remains the same in most of the series at hand. Specimens with the most complete folds have a broad median dark stripe with a pair of dorsolateral gray stripes from eye to rump.

This species may be related to *Microbatrachylus bransfordii* Cope, but that species is a short-legged form, the heel reaching only to the orbit; the teeth are in transverse groups, instead of diagonal groups, the diameter of the tympanum of the male equals eye diameter; the nostril is farther forward; there is no pink lateral band in *rearki.*

There is considerable variation in the details of the folds on the back some portions dropping out, most commonly the paired folds beginning on base of snout and ending on shoulders; sometimes only their posterior portion is left and these with the diverging folds on occiput form a W-shaped pattern. The median fold may extend to the snout.

The ventral coloration is nearly constant. Sometimes some dark spots on sides are dimly rimmed with white.

The species is named for Mr. John Reark who provided me with much transportation and obtained numerous specimens for the collections.

Microbatrachylus costaricensis sp. nov.

Figure 17

Type: R.C.T. No. 372, Morehouse Finca, approximately four miles south of Turrialba, Costa Rica, June 12, 1947. Richard C. Taylor coll.

Diagnosis: A diminutive species without web; without widened discs on fingers and only small ones on toes, the discs slightly pointed and the larger ones somewhat asymmetrical; vomerine

FIG. 17. *Microbatrachylus costaricensis* sp. nov. Type, adult female, R.C.T. No. 372; Morehouse Finca, approximately 4 mi. S Turrialba, Costa Rica. Actual snout-to-vent length, 17 mm.

teeth present in somewhat diagonal rows; ostia pharyngea larger than choanae; inguinal gland nearly equal to area of eye; head and eyelids smooth; chin minutely granular, venter and thigh with rather flat granules.

Description of type: Small adult female (17 mm.) the head rather narrow, distinctly narrower than body; canthus moderately distinct, rounded; upper eyelid nearly smooth but with edge bearing a somewhat thickened ridge that is continuous with the upper edge of a rather broad indistinct low fold above the tympanum, widening somewhat as it bends down behind tympanum; tympanum very distinct, semitransparent, a little higher than long (1.6 x 1.5 mm.), its greatest diameter in length of eye (2.5 mm.), 1.55 times; dis-

tance of eye from nostril, 2 mm.; length of snout, 2.4 mm.; width of upper eyelid, 1.55 mm., much less than interorbital distance (2.2 mm.); distance between tympanum and eye 1 mm.

Choanae rather large, lateral; vomerine teeth present in two triangular fasciculi, their anterior level reaching posterior level of choanae; teeth diagonally placed, converging mesially, separated by a distance equal to or a little greater than width of a fasciculus; ostia pharyngea larger than choanae; tongue narrow anteriorly, much wider and rounded posteriorly, without notch; (male presumably without vocal sac).

Arm short, the wrist barely reaching the tip of the snout; hand very small, digits without distinct discs, rather pointed, the first and second fingers nearly of equal length; subarticular tubercles relatively very large and supernumerary tubercles very distinct but smaller; a well-defined inner metacarpal tubercle; a large rounded palmar pad; a row of indistinct tubercles on underside of arm.

Leg short, the tibiotarsal joint reaching to near middle of orbit; subarticular tubercles elongate pointed, directed forward; supernumerery tubercles small distinct; largest toe discs not half width of tympanum, somewhat asymmetrical; an inner and an outer metatarsal tubercle, the outer only a little smaller than inner, almost no trace of an inner tarsal fold; a very indistinct outer fold.

Dorsal surfaces nearly smooth but with traces of small tubercles especially on shoulders, on arm and legs; chin smooth with only a faint suggestion of granulation; venter with indications of rather large granules; almost entire ventral and posterior surfaces of thigh granular.

Color: Above light brown with a pair of almost obsolete lines or ridges from eyes to a median point near middle of back terminating in two closely approximated black spots; some dim darker marks on snout and a larger dark area on region between eyes and on occiput; a large deep black spot above and behind tympanum partially covering it; deep black spots on arm and a spot on each side behind and above arm insertion; a light brown diagonal band on side and a similar band crossing rump; legs barred with darker color, with a few dark spots near heel and on foot; venter powdered with black, each granulation without pigment; some tiny blackish spots on each side of breast; inguinal gland cream-white; posterior surface of thigh dark lavender the granules lighter; a pair of deep black spots above vent separated by a narrow cream line; a series of small cream spots on upper lip, and a pair of cream tubercles below and behind tympanum.

Measurements in mm.: Snout to vent, 17; head width, 6.6; head length to jaw angle, 7; length of eye, 2.5; greatest diameter of tympanum, 1.6; interorbital width, 2.2; arm, 9; leg, 26; tibia, 8.5; foot and tarsus, 11.4.

Remarks: The relationship of this species seemingly is not closer to one species of *Microbatrachylus* than to another. The type is an adult female with ripe or near ripe eggs. The specimen was taken at night in forest.

Genus ELEUTHERODACTYLUS Duméril and Bibron

Type of genus: *E. martinicensis.*

The genus *Eleutherodactylus* has been a difficult one to study, the difficulties due largely to the inadequate data given in the type descriptions and in part to the remarkable variation (or what I am interpreting as variation) in the forms discussed under the species *podociferus.* Here there appears to be a linkage between color pattern and the arrangement of glandular folds on the back and to a lesser extent with the character of the tubercles on the digits, palms and soles. There may be considerable variation in some of the other species in regard to color pattern variation but it is very unusual to have varied color patterns appearing with different structural characters. Usually such distinctions serve to delineate species. Only by series of breeding experiments can my present arrangement be confirmed or disproved.

Cope, who named three presumed species, *habenatus, podociferus* and *muricinus,* later came to a conclusion that he was dealing with a single species. His material however was doubtless in a bad state since he makes no mention of the varied arrangements of the dorsal folds. I believe that Cope, as well as several other writers, err in regarding these three forms as synonyms of *Eleutherodactylus rhodopis.* I have figured the hand of *rhodopis* and *podociferus* so that others also may distinguish them.

The total number of forms of *Eleutherodactylus* here considered is twenty-seven (species and subspecies).

Certain other species have been reported, i. e. *bocourti, longirostris, punctariolus, ventrimarmoratus,* and *rugulosus,* but in each of these cases I have suspected that the reports may be based on species other than these; but in this I may be wrong. It is highly probable that most of the species occurring in northern Panamá, in the southern part of the Talamanca range, will be found within the confines of Costa Rica eventually.

In the collections at hand are certain forms that I have been un-

able to deal with at this time. Certain of them possibly represent undescribed species.

KEY TO COSTA RICAN SPECIES OF ELEUTHERODACTYLUS

1. Very broad-headed frogs, the head normally wider than body, bearing a well-defined pair of dorsal folds (or rows of tubercles) that form an ornate hourglass-pattern; and pair of bony crests on occiput (except in very young specimens); heel reaches to nostril; length, 103 mm. ..... *rugosus*
   Heads usually not or only slightly wider than body, lacking a pair of bony longitudinal occipital crests 2
2. Vomerine teeth absent, hidden by gums or on very small rather indistinct fasciculi; usually not visible without lens (except *altae* and possibly *pardalis*); tympanum small or sometimes absent 3
   Vomerine teeth (except in *diastema*) in relatively large fasciculi visible to eye, always situated behind posterior level of choanae; tympanum always present, that of male often much larger than female 7
3. Without discrete white, red or orange spots on thighs and in groin, 4
   White, red or orange spots on thighs and in groin 6
4. Tympanum hidden; no vomerine teeth; first finger shorter than second; discs large, those of toes larger than fingers; skin roughly plicate on head, sides and back; belly strongly granulate; (vocal slits and sac?); (size?) ..... *lutosus lutosus*
   Tympanum present, variable in size; skin never plicate; rugosity and discs variable; belly variable 5
5. Skin smooth above and without granulations on venter; a median red stripe; rosy or orange on venter; head broad, depressed, with wide interorbital space; vocal sacs and slits; length, 27 mm. ..... *hylaeformis*
   Skin rather smooth, with a few tubercles on eyelids and back; usually a W-shaped pattern on shoulders; venter granular, yellowish olive above, some pink in groin and on limbs; entire under surface with a peppering of dark pigment; length 24 mm. ..... *ridens*
6. Silvery white spots on side and anterior aspect of thigh; tympanum very indistinct one third eye diameter; digital discs large, round; inner and outer metatarsal tubercles vestigial; heel to tip of snout; skin smooth, belly granular (vomerine teeth probably present; none mentioned in the description save that it is placed in *Eleutherodactylus*); length, 25 mm . *pardalis*
   Coral red or orange spots or stripes on thigh, tibia and groin; grayish flesh on venter; tympanum small less than one third eye length; digital discs large; metatarsal tubercles distinct; heel to middle of eye; skin smooth with some tubercles on head; venter granular; vomerine teeth rather distinct; length, 20 mm. ..... *altae*
7. Toes usually with distinct web or web remnant; if without web, the digits elongate, the discs only moderately large 10

Toes and fingers relatively short with large digital discs; no web present; vocal sac and vocal slits present or absent 8

8. Tympanum visible but extremely small, less than one sixth diameter of eye; vocal sac and slits absent in male; variable in color, sometimes dark, sometimes light below; length, 38 mm. ... *dubitus*

Tympanum larger; a vocal sac and vocal slits present 9

9. Diminutive species with relatively smooth skin, flat indistinct subarticular tubercles, strong external vocal sac evident; venter not or but slightly granular; vomerine teeth absent or a small pair of vomerine elevations with or without teeth; tympanum of male and female about same size; length, 24 mm. ..... *diastema*

Larger; venter strongly granulate; discs large, equal to half eye length; W-shaped pattern more or less evident on occiput; tympanum one third length of eye ..... *cerasinus*

10. At least part of toes one half or more webbed 11

Toes not webbed or less than one half webbed 12

11. Very large species, somewhat toad-like; toes nearly fully webbed; length, 85 mm. (*fide* Dunn) ..... (*punctariola*)

Smaller species, the four inner toes one half or more webbed; two outer toes less than one half webbed; discs truncate, first finger shorter than second; first finger in male greatly thickened; tympanum of male five sixths eye length; length, 44 mm. ♀, 29 mm. ♂ ..... *crassidigitus*

12. Legs long, the heel of adpressed limbs reaching one or more millimeters beyond snout tip 13

Heel not reaching beyond snout tip 21

13. Side of head with a black or purplish-black stripe from tip of snout across lores and tympanum and running down to a point on side of body, contrasting with the dorsal color; only a trace of webs on feet (rarely this dark color is segregated into discrete spots on side of head in *gollmeri*) 14

Side of head and body not so marked 15

14. Heel reaches several millimeters beyond tip of snout; a straight dorsolateral fold from eye to groin; venter and throat smooth; a broad discoidal disc; sharp tarsal fold, slight trace of web on feet; dim, more or less longitudinal marks on back; limbs dimly barred; length, 60 mm. ♀, 30 mm. ♂ ..... *noblei*

Heel reaches six millimeters or more beyond tip of snout; supratympanic fold continued only to above arm; a pair of small (often black-bordered) tubercles on back, a little behind level of arm insertion; trace of web remnant between three inner toes; no dorsal stripes; very little sexual difference in size; length, 33 mm. ..... *gollmeri*

15. Venter strongly granular, digital discs small; vomerine teeth in two very small groups; first toe shorter than second; heel beyond tip of snout; tympanum one half to one third eye length; toes without web trace, head flat; above brown, yellow beneath; length, 27 mm. ..... *peraltae*

Venter without granulation, smooth or nearly so 16

16. Entire dorsal surfaces of body and limbs corrugated, visible to naked eye, with a few very small tubercles sometimes evident on rump; body and head relatively slender, with somewhat elongate head; a small web remnant; two inner fingers with small, two outer fingers with large, terminal discs; heel reaches four millimeters beyond snout; vocal sac in male; first finger as long as second; length, 47 mm. ♀, 30 mm. ♂ ..... *talamancae*

Entire dorsal surfaces not corrugated, or if so, can be discerned with a lens only; usually some trace of folds or rugosities or dorsal surface entirely smooth; body and head not slender; web or web remnants may or may not be present 17

17. Digital tips wide, truncate; part of toes one fourth to one third webbed; trace of web between three inner fingers; heel 10 mm. beyond snout; a light line under chin; hair-fine dorsal median line; back of thigh black, with white or silver spots; length, 72 mm. ..... *palmatus*

Digital tips not truncate 18

18. First finger longer than second 19

First finger not longer than second 20

19. No vocal sac; back of thigh black with silver or white spots; toes one-fourth webbed; tympanum round, its diameter three fourths length of eye; no nuptial asperities on first finger of male; length, 60 mm., ♀, 51 mm. ♂ ..... *pittieri*

(Vocal sac in males?) tympanum oval one half eye (♀); rudimentary web between inner fingers; toes one-fourth webbed; yellow vertebral line, and yellow gular line; hind part of thigh conspicuously marbled with black and white ..... *engytympanum*

20. First finger shorter than second; finger discs larger than toe discs; vomerine teeth in widely separated series; tongue subround; tympanum narrow vertical oval; skin smooth; (vocal sac?); length, 50 mm. ..... *melanostictus*

First two fingers equal; tympanum round, almost equal to eye; toes one-fourth webbed; vocal sac and slits present; nuptial asperities present in male on first finger; length, 35 mm. ♂ ..... *fleischmanni*

21. Heel to tip of snout; toes with a small web, canthus rostralis distinct nearly straight, digital discs truncate; outer metatarsal tubercle obsolete; tympanum one half eye-length (sex?); skin nearly smooth or a pair of feeble folds on scapular region; snout projecting beyond nares and lip; length, 26.5 + ... *ranoides*

Heel fails to reach nostril 22

22. Venter granulate 23

Venter not granulate 24

23. Venter finely granular over all or a considerable part of its surface; usually one or two short diagonal skin folds from eyelid; numerous tubercles or nearly smooth; discs large, truncate; vocal sac and slits in males; web remnant only indicated; heel to near nostril; digital discs large truncate; length, 57 mm. ♀, 42 mm. ♂. ..... *platyrhynchus*

Venter strongly or weakly granular; skin folds variable often an hourglass-shaped figure discernible; discs or finger not or scarcely wider than digits, not truncate; vocal slits in males; color somewhat variable (*habenatus* var.); length under 35 mm. ..... *podociferus*

24. Digital discs of hand not wider than digit; venter smooth or sometimes wrinkled; abdominal discoidal disc often distinct; folds on back, as well as the coloration extremely variable; vocal slits in males; length, under 35 mm. ..... *podociferus*

Digital discs of hand and foot always more or less widened, at least wider than digit 25

25. First and second fingers equal or of about equal length 26

First finger longer than second 27

26. Heel to between eye and nostril; no distinct canthus; discs small; digits without trace of web or dermal margins; venter smooth, with a discoidal disc; skin smooth above; tympanum oval two thirds eye female; length, 75 mm. (vocal sac in males?) *euryglossus*

Heel to between nostril and eye; head wider than body; canthus angular; vomerine teeth in oblique groups; venter smooth, finely rugose above; dark brown above, greenish blue marbling on side lighter below with a light (red?) line from eye to sacrum (resembling superficially *Phyllobates lugubris*); discs of fingers and toes well developed about half again diameter of digit, length 38 mm. (sex?) ..... *gaigei*

27. Heel not reaching anterior edge of eye, digital dilations small, flat tubercles under fingers; venter smooth, posterior face of leg black banded with dark areas separated by scarlet areas; posterior side and anterior abdomen blackish or brownish with crimson or orange spots; digital discs small; length, 35 mm. *florulentus*

Heel does not reach tip of snout; lacking web on hand and foot; a tarsal fold; four indefinite longitudinal bands on dorsum; venter smooth, length, 44 mm. (vocal sac in male?) ..... *nubilus*

Fitzingeri having the following known characters, does not fit into this key: Very slim body; vomerine teeth far behind choanae; venter smooth; dorsum smooth, (with a few elevations), flanks granulated; toes with a web remnant; gray brown above with black flecks and streaks especially on limbs; a yellow streak from tip of snout runs under jaw; the tip truncated anteriorly; venter yellowish; snout to vent, 30 mm., hind legs, 54 mm., arms, 18 mm.

Eleutherodactylus lutosus lutosus (Barbour and Dunn)

Syrrhophus lutosus Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, pp. 158-159 (type locality, Navarro, Costa Rica. E. R. Dunn coll.)

Diagnosis: A small frog (no measurements given in the type description) without vomerine teeth; canthus rostralis ill defined; tympanum hidden; first finger shorter than second; discs rather

triangular, larger than discs on fingers; two metatarsal tubercles; belly strongly granular.

Description of species: (From Barbour and Dunn, *loc. cit.*). "Size small, body depressed; head as broad or slightly broader than the body; as broad as long; snout blunt with very ill defined canthus rostralis; orbital diameter about equal of distance from eye to nostril; nostril very near tip of snout; interorbital space about equal to width of upper eyelid; vomerine teeth absent; tympanum hidden; fingers 2, 3 and 4, with slight but well defined dilatations; first without disc and shorter than second; toes long, second and fourth equal; no trace of web; with discs more triangular and slightly larger than those of fingers; subarticular tubercles, long, rather well developed; a very indistinct outer, and a long, rather well developed, inner metatarsal tubercle; tibiotarsal articulation reaching to half way from eye to tip of snout; skin roughly plicate on head, sides and back; belly strongly granular.

"Color in alcohol (fresh, well preserved specimen not shrunken): Dirty black, a faintly defined middorsal light thread like mid-line; thighs narrowly cross barred black on dark brown. Belly dirty dark brown."

Eleutherodactylus hylaeformis (Cope)

Phyllobates hylaeformis Cope, Journ. Acad. Nat. Sci. Philadelphia, 2nd ser., vol. 8, 1875, p. 107, pl. 23, fig. 8 (type locality, Talamanca, Pico Blanco, 7000 ft. elev. Costa Rica; W. Gabb coll.); U. S. Nat. Mus. Bull. 32, 1882, p. 17; Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 67; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 1882, pp. 196-197.

Syrrhopus hylaeformis Boulenger, Proc. Zool. Soc. London, 1888, p. 206.

Syrrhaphus hylaeformis Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Apr. 1900, p. 218.

Syrrhophus hylaeformis Nieden, Das Tierreich, Lief. 46, Anura 1, 1923, p. 401.

Diagnosis: A small species 27 mm. in length; canthus obtuse; skin smooth above and below. Red stripe on middle of dorsum.

Description of species (From Cope): "A species of medium size, resembling a *Hyla* in its habit. The head is a broad oval, and the muzzle is not produced, but is depressed. Interorbital space wide, plane; canthus rostralis obtuse, straight, lores oblique. Tongue an elongate oval narrowed before, flat, one-half free. Ostia pharyngea very minute; membranum tympani one-sixth of orbit. Fingers and toes free, dilatations rather large. Skin smooth above and below.

"Color above rich brown, divided on the vertebral line by a narrow red stripe. Femora light brown before and behind. Gular region with large vocal sac, of a rose color. Abdomen and inferior surfaces of femur and tibia with a rosy or orange pigment."

Measurements in mm.: Length of head and body, 27; length to orbit, 3; to angle of jaws, 9; width between jaw angles, 10; width between orbits, 3; length of arm, 17; hand, 6; hind limb, 37; hind foot, 18.

Presumably this species is known only from the mountain of Pico Blanco, at 7000 ft. elevation, the type locality. I am not sure as to the relationship of this species but doubt that it is close to *Eleutherodactylus ridens* or *Eleutherodactylus caryophyllaceus* both of which have the venter granulate.

Eleutherodactylus ridens (Cope)

Figure 18

Phyllobates ridens Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 131 (type locality, Río San Juan, Nicaragua. Robt. Kennicott coll.); Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 155 (Panamá); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale. Étude sur les Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 66; Boulenger, Catalogue of the Snakes in the collection of the British Museum, 2nd. ed., 1882, p. 197.

Hypodictyon ridens Cope, Proc. Amer. Philos. Soc., vol. 22, July 29, 1885, p. 383, (establishes the genus *Hypodictyon* for the forms with granulated venters).

Syrrhopus ridens Boulenger, Proc. Zool. Soc. London, 1888, p. 206.

Syrrhaphus ridens Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Apr. 1900, p. 216.

Diagnosis: Maximum length 24 mm.; heel reaching near front of eye; tympanum moderately distinct, rather high on side of head, its vertical diameter (1.2 mm.) more than one third eye length (3.7 mm.); a vague W-shaped mark on occiput, preceded by a darker median mark that touches an interorbital dusky bar; posterior half of body with indistinct diagonal lines directed toward groin, converging on median line; limbs more or less barred; a small tarsal fold or tubercle; a large inner metatarsal tubercle equal or nearly equal to distance between tubercle and disc of first toe; vomerine teeth present, but indistinct, much behind choanae and not on elevated bosses; venter granular, chin smooth.

Description of species: (From K.U.M.N.H. No. 28254 ♀, taken near Guápiles, Costa Rica.) Head broad, triangular, its width (9 mm.) greater than its length (8.6 mm.); canthus rostralis rounded but distinct; nostril not swollen; tip of snout rounded, projecting 1 mm. beyond lower lip; length of eye (3.7 mm.) shorter than snout (4 mm.); nostril 2.5 mm. from eye, much closer to notch in upper lip; loreal region not or but slightly concave, sloping obliquely to lip: the line of the lower jaw posteriorly curves back upward, strongly overlapping upper jaw; eye large the upper lid (2.8 mm.) wider than interorbital space (2.4 mm.); tympanum higher than long (1.2 mm. x .95 mm.) its greatest height little more than one third length of eye; tongue longer than broad, minutely

notched behind, thickened somewhat on posterior edge, and broader behind than in front; (in other specimens not widened behind but about same width and the terminal parts thickened); tongue free behind for more than half its length, and widely free on sides; vomerine teeth very indistinct, but visible under lens, in two groups between inner levels of choanae, but a little behind their posterior level; choanae lateral in position, moderate in size.

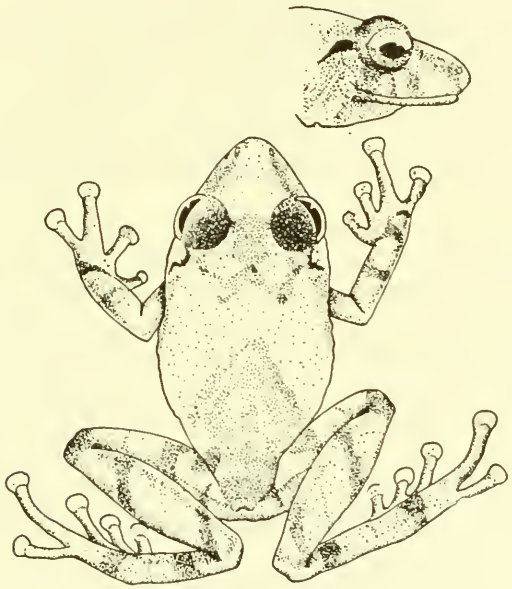

FIG. 18. *Eleutherodactylus ridens* (Cope). K.U.M.N.H. No. 28254 ♀; Los Diamantes, near Guápiles, Costa Rica; snout-to-vent length, 23.2 mm. The tympanum is a little more distinct in lateral view than is shown.

Skin of dorsum smooth with a few indistinct tubercles on top of head, a prominent one on eyelid, five on occiput marking points of the W-shaped mark; one large tubercle behind angle of jaw and a few indistinct ones on rump; sides anteriorly strongly granular as is venter and most of the ventral part of femur and a broad area on each side of vent; a distinct heel tubercle; chin, throat and limbs smooth; a supratympanic fold curves up and over tympanum, partly obscuring its upper edge.

Arm short, the wrist fails to reach snout; a smooth tubercle on dorsal surface of arm and two or three on the ventral surface; fingers without trace of web, moderately long, the first smaller and shorter than second; all digits with discs increasing from first to fourth in

size, the fourth more than double area of first but not quite double its width; subarticular tubercles and supernumerary tubercles distinct on palm; a ventral inner metacarpal tubercle at base of first finger; median palmar tubercle bifid or nearly tripartite.

Legs short, heel reaching anterior edge of eye; heels touching when legs are flexed at right angles to body; toes without trace of web, all with discs, those of inner toes small, scarcely wider than digits, those of outer toes large, equal or nearly equal to those of outer fingers; subarticular tubercles distinct; supernumerary tubercles of sole small indistinct; a large inner metatarsal tubercle, its length equal to distance from tubercle to the disc; a small outer tubercle present. A small tarsal tubercle one third the length of tarsus back from inner metatarsal tubercle; a prominent heel tubercle.

Color: Generally yellowish olive on dorsum; upper surface of fingers pinkish; area in groin, the front and most of posterior surface of thigh, part of tibia and foot reddish pink; sides yellow, gradually merging into reddish pink of groin; anal region olive-gray. Dusky pigment in preserved specimens shows a very dim W-shaped pattern on occiput, and in middle of back is the apex of a triangular darker area the outer edges of which are fairly distinct, broad diagonal stripes; a dim dusky bar between eyes followed by a contiguous interorbital spot; a dim line on upper loreal region and a discrete spot on fold and tympanum behind eye; granular area in anterior part of side somewhat darker; legs and arms with dim dusky bands and considerable dark pigment on outer posterior faces of thigh; entire under surfaces except discs and tubercles of feet with a peppering of dark pigment.

Measurements in mm. of Eleutherodactylus ridens

	Number		
	28254 ♀	28252 ♂	28253 ♀
Snout to vent	23.2	17.	21.3
Length of snout	4.	2.8	3.7
Length of eye	3.7	2.6	3.
Width of head	9.	6.	8.4
Length of head	8.6	6.5	8.
Upper eyelid	2.8	2.	2.3
Interorbital space	2.4	2.	2.1
Tympanum	1.2 x .95	.8 x .8	1. x .8
Arm	12.3	9.	11.3
Hand	6.2	5.3	6.
Leg	33.5	24.5	30.
Tibia	11.5	9.	11.
Foot and tarsus	15.2	12.	14.9

Variation: No. 28253 has the general color darker, and the diagonal stripes more distinct from middle of back to groin; just behind these is another pair, more or less distinct, and behind these some indefinite spotting; everywhere on the dorsal surfaces the pigment is a little heavier. In this specimen the skin is slightly rugose in the posterior part of back and on upper surface of leg; the tibiotarsal articulation reaches a millimeter beyond eye.

The male has a vocal sac, and vocal slits are present in the mouth. In some specimens, the tongue is slightly wider behind than in front (in the described specimen it is spread more than normal). There are five spots on the lip, three radiating from eye in most of the specimens. These may be dim and scarcely discernible. A ventral discoidal disc is dimly evident in some individuals, terminating before thigh is reached.

The specimens were taken near Turrialba (No. 28253 Morehouse Finca, 4½ mi. south) and Los Diamantes, one mi. S Guápiles (Nos. 28252, 28254). They were obtained from bromelias and on the ground. The first finger of the male has a swelling at its base and on it minute asperities are visible under magnification. Several specimens were obtained at Moravia, at Bataan and others at Turrialba in 1951.

There is some variation in the size of the digital discs and much variation in color. One young specimen has narrow yellow-white lines following the canthus and broad lines of the same color from eye to groin; the upper part of arm is cream-white, and there is only one diagonal line on each side. Another specimen has the diagonal lines on sides of body continuous with lines crossing legs, when folded legs are pressed against body in the typical sitting posture. A third young differs from both of these, but all have more pigment on venter and under limbs than do adults, and in all it is equally distributed save in groin where, as in adults, there is no pigment.

Eleutherodactylus caryophyllaceus (Barbour)

Figure 19

Syrrhopus caryophyllaceus Barbour, Proc. New England Zool. Club, vol. 10, March 2, 1928, p. 28, pl. 2, fig. 1 (type locality La Loma, on the trail from Chiriquicito to Boquete, Boca del Toro province, Panamá, in cloud forest; Dunn and Duryea, colls.).

Eleutherodactylus caryophyllaceus Dunn, Copeia, 1937, No. 3, p. 163 (La Hondura).

Diagnosis: This form may be diagnosed by its small size (23.2 mm.), by its generally yellowish or pinkish color in life, or in preservation, by the very slight amount of pigment scattered over the pinkish flesh color of body dorsally and ventrally; usually two tiny

black spots, present on median line of back, form the apices of two pairs of converging diagonal rows of dark pigment dots extending from sides; digits unwebbed, with small discs; snout much elongated, the canthi sharply distinct; limbs with narrow often very indistinct darker bars; sometimes dim, darker bars across snout.

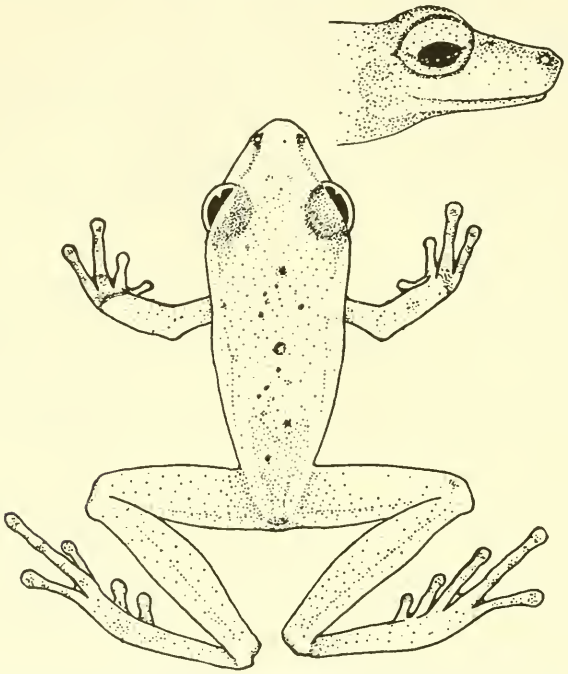

FIG. 19. *Eleutherodactylus caryophyllaceus* (Barbour). K.U.M.N.H. No. 28202; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 21 mm. (The tympanum is slightly more distinct than shown in the figure, and the digital discs are a little larger, the discs in the specimen having been slightly dessicated.)

Description of species: (From K.U.M.N.H. No. 28202.)—Head somewhat triangular, its length (8.3 mm.) distinctly greater than its width at jaw angles (6.9 mm.); eyes moderately large, the length of eye (2.7 mm.) equals its distance from nostril (2.7 mm.); top of snout very flat, in a single plane, the slight swellings about nostrils not causing any depression between nostrils; canthi distinct, appearing sharp, but actually slightly rounded; tip of snout extends considerably beyond nostrils and overhangs mouth .8 mm.; tympanum rather indistinct, irregular, its greatest diameter (in a paratype) is 1 x .8 mm., a little less than a third of eye length; loreal region not

or but very slightly concave, sloping straight down to lip; upper eyelid, 1.6 mm.; interorbital width, 2.5 mm.

Vomerine teeth one to three in minute fasciculi, not or scarcely elevated, situated between inner level of choanae but not reaching forward to their posterior level; choanae large, somewhat lateral, separated from each other by a distance equal to 3½ times transverse diameter of one choana. Tongue longer than broad, with a small median emargination behind, free for half its length. (Vocal sacs present in males, the slits lying somewhat mediad, at a considerable distance from jaw.)

Skin generally smooth on dorsal surface of body, however a few minute tubercles present on side of snout under eye, around tympanum and on sides of body; a pair of tubercles on shoulders and a median one somewhat in front of these, marks the apex of an inverted V as they are connected with a dim line extending on sides; somewhat behind these is a median tubercle marking apex of two diagonal lines from groin that may have one or more tiny tubercles in evidence; abdomen granular, chin and breast smooth; under surface of thigh and region about vent with larger granules.

Arm short, the wrist fails to reach tip of snout; first finger distinctly shorter than second, all with symmetrical discs, first smallest, the fourth largest; subarticular tubercles rather indistinct; supernumerary tubercles scarcely discernible; an inner metacarpal tubercle on outer edge of base of first finger; the palmar tubercle large, partly divided.

Leg slender, the heel reaching halfway between nostril and eye; toes lacking webs, with small discs, symmetrical, or the fourth toe slightly asymmetrical; subarticular tubercles rather obscure; supernumerary tubercles present but indistinct; inner metatarsal tubercle large, distinct, its length nearly equal to length of toe beyond tubercle; outer metatarsal tubercle present; tarsus lacking both inner and outer folds or tubercles; a single well-defined tubercle on edge of eyelid, two on upper surface of arm and two or three on dorsal surface of femur.

Color: General color in life lively pink when captured, and after an hour or so it became yellow with scarcely a trace of pink. When first preserved the pink was again in evidence on back and sides, chin yellow, venter white, legs flesh-color with some pink on toes. After some days in formalin preservation, the specimen became flesh-white. There is a faint trace of a dark bar between eyes and two small brownish dusky dots on base of snout; dorsal

tubercles dusky edged; an indistinct dusky line along upper edge of loreal region; an inverted V-shaped mark on shoulders and a pair of lines from groin converging to a point on middle of back; limbs faintly barred with dusky; below flesh color, almost lacking pigment; eyeball, seen through lid, black.

Measurements in mm.: Snout to vent length, 21; head width, 6.9; head length, 8.3; eye length, 2.7; eye to nostril, 2.7; snout length, 4; arm, 11; hand, 4.8; leg, 31; tibia, 11; foot and tarsus, 13.

Remarks: I discovered the described specimen at Isla Bonita on the Caribbean slope of Volcán Poás (elevation 5000 ft.) in the leaf sheath of a fallen palm leaf. It was especially active and it was captured only after a hectic chase. The specimen agrees with two paratypes in the E. H. Taylor-H. M. Smith Collection in all essential detail.

A series of six specimens were captured at night at Moravia (K.U.M.N.H. Nos. 30861-30866). These varied from yellowish to olive-yellow with scarcely a trace of pink, the young being more distinctly yellow than the adults. One specimen was light orange-brown. The most unusual pattern is found in No. 30864. Here there are light unpigmented yellow lines from nostrils to eye along the canthi, continuing behind eye to groin. They are bordered above by dark lines that are connected across the shoulders and indistinctly connected across the middle of the back. All specimens with scattered pigment on venter.

Most of the specimens have the interorbital dark bar present; and No. 30861 has a small medial triangular cream spot between the shoulders. The largest specimen measures 23.2 mm. These specimens were found perched on low shrubs at night. I cannot be certain that I distinguished their call from those of other small eleutherodactylid forms.

Eleutherodactylus pardalis (Barbour)

Syrrhopus pardalis Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 26-27, pl. 1, fig. 2 (type locality, La Loma, Panamá).

Diagnosis: "A wide-headed and slender-limbed species with large digital disks and silvery white spots on side and anterior aspect of thighs.

Description: "Nostril much nearer to tip of snout than to eye, the distance from the eye being slightly less than the latter's diameter; upper eyelids very little narrower than interorbital space; tympanum scarcely observable, about one third diameter of eye or slightly larger; disks of fingers and toes large and round; first

finger without disk, much shorter than second; fourth finger slightly longer than second; first toe very short, with a well developed disk; subarticular tubercles fairly well developed; plantar surface rugose; inner and outer metatarsal tubercles vestigial; hind limb being extended along the body, tibio-tarsal articulation reaches tip of snout; heels overlap considerably when hind limbs are folded vertically to body axis; skin above smooth; belly and posterior side of thighs granulate.

Color: "Very dark brown. Two or three large and conspicuous white spots on each side of abdomen. Three or four similar round conspicuous white spots on anterior aspect of thighs.

Measurements in mm.: "Tip of snout to vent, 25; width of head, 9.5; fore limb, 13.5; hind limb, 42; tibia, 14 mm."

Remarks: This specimen shows a resemblance in markings to *Eleutherodactylus altae* Dunn. It would appear that there are sufficient differences to separate them.

Eleutherodactylus altae Dunn

Figure 20

Eleutherodactylus altae Dunn, Notulae Naturae, No. 104, July 3, 1942, pp. 1-2 (type locality, Caribbean slope of Costa Rica, on the pass between Barba and Irazú below the divide and above the finca of Felix Delgado, approximately 4000 ft. elev.; colls. Dr. and Mrs. E. R. Dunn and F. Nevermann).

Diagnosis: A diminutive species, ♂ 21 mm. First finger shorter than second; fingers and toes without web, but with relatively large digital discs, those on outer fingers and toes asymmetrical; canthus more or less distinct; tongue shield-shaped free for half its length; vomerine teeth considerably behind posterior level of choanae; dark gray above, light grayish flesh below; a coral-red lateral stripe, and a coral-red stripe on anterior face of thigh; a white spot on posterior face of thigh; two such spots or three on the inferior face of tibia. Fifth toe larger than third.

Description of species: (From type specimen A.N.S.P. No. 23815 ♂.) A small species having a length of 21 mm. (20 mm. by present measurement); head length (8 mm.) equals head width; snout blunt, rather elevated, low; canthus distinct, rounded; area about nostrils distinctly swollen with a slight depression between; snout length a little greater than eye length; snout rounding in lateral profile, with a distinct labial notch; tympanum vertically oval (height 1.3 mm.; length, .9 mm.); eye-length, 3.3 mm.; eye to nostril, 2.2 mm.; nostril to median lip notch, 1.5 mm. Width of an eyelid (2.2 mm.) slightly less than interorbital interval (2.4 mm.); elevation of snout (greatest), 2.6 mm.; elevation at nostril, 2.1 mm.

Area about tympanum somewhat swollen; upper eyelid rough with some indistinct tubercles; a moderately prominent tubercle at jaw angle; the vocal sac rather circular reaching on breast; an indication of a breast fold (at least in male); the chin and vocal sac finely granular; loreal region not or but slightly concave, sloping obliquely to lip. Tongue shield-shaped emarginate on posterior edge, free for more than half its length; choanae small, lateral; vomerine teeth in two small fasciculi consisting of few teeth (the area has been scratched with a needle) situated mesially, distinctly behind choanae, not widely separated from each other; ostia pharyngea smaller than choanae.

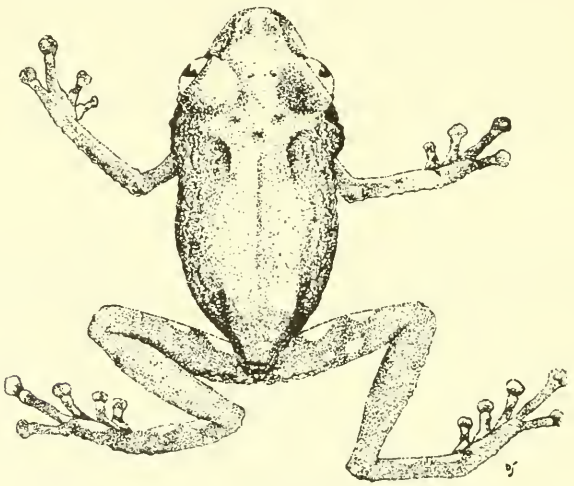

FIG. 20. *Eleutherodactylus altae* Dunn. K.U.M.N.H. No. 28171, Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 19.8 mm.

Arms short, the wrist barely reaching tip of snout. Digits bearing unequal sized discs, some asymmetrical; inner metacarpal tubercle elongate, oval, nearly equal to length first finger between disc and tubercle; outer tubercle somewhat bifid; supernumerary tubercles present; subarticular tubercles smooth, none divided; first finger shorter than second; no webs on fingers but trace of ridges on lateral edges of digits.

Heel reaches to middle of eye; when folded at right angles to body, heels touch but do not overlap. No trace of web on feet; subarticular tubercles on feet small, distinct; inner metatarsal tubercle large, flat, nearly equal to length of first toe; outer tubercle distinct, round; discs equally as large as those on fingers, and def-

initely asymmetrical, particularly those of the third and fourth toes; numerous supernumerary tubercles; indications of an inner tarsal tubercle near the inner metatarsal tubercle; a distinct tubercle on heel; fifth toe longer than third.

Skin smooth above with some tubercles on head; venter granular, as is about half area on ventral surface of thigh; granules below vent irregular, with an indistinct groove behind vent; inguinal gland rather inconspicuous.

Color: Dark gray on dorsal surface of body and head; lighter gray on under surfaces; a large elongate inguinal spot extending nearly half length of body and continuous with a similar elongate spot covering front of thigh (coral-red in life); two white spots on under surface of tibia and one on the front of the tarsus; a white spot on the posterior surface of thigh.

Measurements in mm. of Eleutherodactylus altae

	Number	
	Type ♂	28171 ♀
Snout to vent	20	19.8
Width of head	8	9
Length of head	8	9
Length of snout	3.6	3
Length of eye	3.3	3.1
Arm	13.1	13
Hand	5.5	5.4
Leg	28.4	29.5
Tibia	10.3	10
Foot and tarsus	12.5	13

Variation: I obtained a single specimen (K.U.M.N.H. 28171) from a bromelia growing on a fallen branch at Isla Bonita, Volcán Poás. A second specimen in the same plant escaped. The species is especially active for its small size.

My specimen agrees with the type in most essential characters but a few differences are in evidence, and there is some difference in the details of the color. The inner metacarpal tubercle is somewhat shorter and the outer metacarpal tubercle is more distinct and divided for a greater distance. The inner metatarsal tubercle is slightly shorter, proportionally. The toe discs on the two outer toes actually are a little larger than those on the two outer fingers.

Some other characters evident in my specimen (female) that are less evident in the type are: tongue relatively very large, broadened behind, narrowed anteriorly, emarginate posteriorly, free for three fourths of its length. The vomerine teeth in two somewhat longitudinal groups, beginning anterior to the posterior level of choanae,

extend behind it for some distance. Choanae rather large, nearly lateral, half-moon shaped, their greatest length in distance between them, approximately 2.8 times. A ventral discoidal disc present with the folds on side distinct anteriorly, but posteriorly indistinct so that it is impossible to say whether they terminate in front of thigh or not.

Leg short, the heel reaching anterior edge of eye when brought forward; fifth toe reaches farther forward than third; no trace of an inner tarsal fold; two or three tubercles along outer edge of tarsus representing a remnant of an outer tarsal fold. Nostrils separated by a distance greater than their distance from the deep notch in upper lip; but smaller than their distance to eye. There are more or less distinct curved canthii behind occiput, and five symmetrically arranged tubercles on the head and occiput (see figure).

The color in life is generally blackish above and along the sides; below somewhat lighter but heavily pigmented with brownish black; chin lighter, the pigment (under lens) is seen to be flecked and reticulated with lighter color; three or four very small reddish flecks on both upper and lower lip; a large red-orange spot in front of elbow joint; and a large axillary red-orange spot; a large red-orange area in groin in contact with (or narrowly separated from) a large rounded spot of same color on the anterior face of femur; three other rounded smaller spots on same side of femur; posterior face of femur black, each with a red-orange spot and a white spot; under surface of tibia with numerous white spots, some partly fused together; dorsoanterior surface of tarsus and inner toes with white spots.

Remarks: One other species that I know only from description suggests relationship to this species. This is *Syrrhophus pardalis* Barbour °. From *pardalis* it is presumed that *altae* differs in the presence of vomerine teeth (not mentioned but placed in a genus usually lacking these teeth); it differs in having deep coral-red or red-orange colored spots rather than silvery white spots (possibly faded?), in the asymmetry of the discs of the outer fingers and toes (in *pardalis* they are "round"); in the shorter limb, (in *pardalis* the heel reaches tip of snout); in the failure of the heels to overlap when limbs are folded† (overlap considerably in *pardalis*). This species measures as follows: length, 25 mm.; head width, 9.5 mm.; arm, 13.5 mm.; leg, 42 mm.; tibia, 14 mm.

The measurements of *S. pardalis* show interesting differences;

° *Syrrhopus* (*sic*) *pardalis* Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 26-27, pl. 1, fig. 2.

† Barbour mentions *Tomodactylus simulae* (*sic*) Günther in comparison. *Tomodactylus amulae* is intended—a very different species as he suggests.

altae has a snout-vent length of 20 mm., *pardalis* 25 mm. The arm in both forms is practically the same, 13.1 and 13.5; however the leg in *altae* (in female) is 29.5, in *pardalis*, 42.

The tympanum is slightly more distinct than is shown in the figure, and the terminal discs of outer digits are somewhat more expanded than shown, since on this specimen they have been somewhat dessicated.

Eleutherodactylus diastema (Cope)

Lithodytes diastema Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 155-156 (type locality, "Camp Mary Caretta," Panamá); Proc. Amer. Philos. Soc. 1886, vol. 23, p. 274 (Nicaragua); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Hylodes diastema Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, ed. 2, 1882, p. 212; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 238; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 432-433.

Hyla chica Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, June 20, 1918, pp. 335-339, pl. 18, text figs. 3-6.

Eleutherodactylus diastemma (*sic*) Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 32, 1921, p. 161 (Costa Rica).

Eleutherodactylus diastema Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 411-412.

Syrrhopus ineptus Barbour, Proc. New England Zool. Club, vol. 10, 1928, pp. 25-26, pl. 1, fig. 1. (I have examined the type [MCZ. No. 13050]. The pads on the toes shown as being minute in the figure actually are larger).

Diagnosis: This form may be diagnosed by the following: diminutive hylalike frogs (maximum size for females 24 mm., of males 20 mm.); the skin smooth or occasionally with some scattered small tubercles on sides of head or body; tympanum diameter nearly half length of eye; fingers and toes with relatively large discs, without a trace of web, the two outer toes seem more closely bound together at the basal metatarsals than are the other toes and the outer toe seems to arise from a point farther forward than the third toe; tubercles under hand and foot rather indistinct; vocal sac and vocal slits in male.

Description of species: (From K.U.M.N.H. No. 24981 ♀.) Head rather oval, moderately rounded, with the canthus rostralis rounded; eye large, as long as the snout; nostrils lateral, area about them slightly swollen; tip of snout bearing a minute point or "nose" (not invariably discernible); tympanum distinct its diameter a little more than one third length of eye, loreal region sloping to lip not concave; tongue large, broadly rounded behind (not emarginate), greatly narrowed in front (greatest length, 6 mm.; greatest posterior width, 4 mm., anterior width, 1 mm.); tongue free for more than half of its length and free at sides; opening of Eustachian tubes small, about one third size of small choanae; choanae rather

widely separated, somewhat lateral in position, partially hidden when seen from below, by shelf from maxillary; small vomerine elevations, without vomerine teeth.

Skin generally smooth but a few small tubercles on eyelid and behind jaw angle; rather granular low on sides, while the venter itself has a suggestion of granulation posteriorly; median part of underside of thighs distinctly granular or areolate; only a faint trace of a supratympanic fold; under lens one may discern fine vermiform folds or corrugation.

Arm short, the wrist reaches the tip of snout; hand short; discs broad, the largest a little smaller than tympanum, the width of largest (1.2 mm.) double width of finger (.51 mm.); first finger shorter than second; subarticular tubercles small, rather flattened not especially distinct; an inner palmar tubercle lateral to base of first finger; a larger median palmar tubercle (may be partially divided); a few small indistinct supernumerary tubercles.

Heel to back part of eye when brought forward; largest discs on toes equal to those on fingers; fifth toe bound more tightly to fourth at base than third; fifth reaches farther forward than the third; no web present on either hand or foot; subarticular and supernumerary tubercles small rather indistinct; outer metatarsal tubercle a little smaller than inner but relatively more elevated and distinct; tarsal tubercle or fold indistinct or wanting.

Color (in life): "Light flesh above, below with a pink wash on thighs and legs; toes salmon."

In alcohol the general color is brownish gray with a faint trace of a median line; below light flesh; under a lens one discerns slightly more pigment on the dorsal surface; the pigment is equally but sparsely scattered over the entire under surfaces including palms and soles; there is faint indication of two rather short lateral lighter lines on sides of back.

Measurements in mm.: Snout to vent, 23.9; width of head, 8.8; length of head, 8.4; length of eye, 3.2; tympanum, 1.15; length of snout, 3; arm, 15; hand, 5.5; leg, 29; tibia, 10; foot and tarsus, 13.

Variation: Males have a large vocal sac, lemon yellow in color; the vocal slits are rather posterior in position. The vomerine elevations are usually visible as two flattened slightly raised areas considerably behind but between inner levels of choanae; the presence of teeth can sometimes be discovered by a needle, even when not appearing above the gums.

Distribution: Specimens were taken at Cervantes and at Isla Bonita in bromelias. None were discovered by hearing them call.

At Los Diamantes however practically all the specimens discovered were calling from low trees at night. Specimens were taken near Empalme and in the National Forest. The species has been reported from Nicaragua to Panamá.

Remarks: This tiny frog, its maximum snout-to-vent length only 24 mm., is commonly found in bromelias, from the lowlands up to an elevation of about 5500 feet. Specimens taken in the daytime from such places are usually brownish often rather dark brown, sometimes with longitudinal lighter lateral lines, sometimes with little or no pattern evident save for two short, lighter lines along the sides of the back. Those taken at Los Diamantes at night calling from branches of low trees and shrubs had a well-defined black pattern on a grayish ground color. These forms differ somewhat from typical specimens from higher elevation so that they may merit subspecific designation. The pads on the toes are a trifle larger, the snout is observably narrower and the toes are free a greater length. The call is a short whistle.

Eleutherodactylus cerasinus (Cope)

Figure 21

Hylodes cerasinus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 112-113, pl. 26, fig. 4 (type locality, eastern slope, Pico Blanco, Costa Rica; W. Gabb, coll.); Brocchi, Mission Scientifique au Mexique et dans l'Amérique centrale; Étude des Batraciens de l'Amérique centrale, livr. 2, 1882, pp. 57-58; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 216; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 15. Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug., 1900, p. 231 (*part.*). (The specimen from La Palma, Costa Rica, is probably not of this species); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 437-438 (*part.*).

? *Eleutherodactylus ceresinus* Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, p. 161 (Zent).

Eleutherodactylus cerasinus Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, p. 411 (Gatun, Canal Zone; Costa Rica).

Diagnosis: A vocal sac present in male; venter very strongly granular; diameter of tympanum one third length of eye; no trace of webs on digits; W-shaped fold or ridge outlined on back of occiput; discs large, distinctly larger than tympanum, equal to half diameter of eye; area behind eye and tympanum rugose.

Description of the species: (From K.U.M.N.H. No 28343.) Head as wide as body, oval in outline; snout much narrowed; canthus rostralis distinct, somewhat rounded, terminating at the swollen area above nostril; a slightly depressed area between nostrils and at tip of snout; latter reaches beyond the line of the mouth 1 millimeter; canthal region not or scarcely concave, sloping very obliquely to lip; eye moderately large; its length (4.2 mm.) about equal to its distance from the nostril (4.1 mm.); length of snout 5.4 mm.; tym-

panum moderate, a little higher than wide (♀), 1.6 mm. in greatest diameter, more than one third length eye; a heavy warty supratympanic fold, tending to obscure upper border of tympanum, forms an angle rather than a curve as it passes down behind tympanum; two large pyramidal tubercles slightly below and behind tympanum.

Vomerine teeth in two very small, slightly elevated fasciculi, well separated mesially, lying within the inner level of choanae, but con-

FIG. 21. *Eleutherodactylus cerasinus* (Cope). K.U. M.N.H. No. 28343; Morehouse Finca, 5 mi. SW Turrialba, Costa Rica; snout-to-vent length, 33 mm.

siderably behind them; choanae about equal in size to opening of Eustachian tubes; tongue oval, cordiform, notched slightly behind, free for nearly half its length. (Males with vocal sac and distinct vocal slits.)

Arm moderately long, the wrist reaching beyond tip of snout; first finger smaller and shorter than second, its disc only slightly wider than digit, those of two outer fingers largest (1.8 mm. wide), much larger than tympanum; subarticular tubercles rather large, distinct; supernumerary tubercles on palm moderately distinct; unequal in size; inner metacarpal tubercle oval; outer palmar tubercle large, more or less completely divided, the inner part largest; four or five distinct tubercles in a row under arm; dorsal surface of fingers and hand with some smooth indistinct tubercles.

Heel reaches to a point between eye and nostril but nearer the latter; toes long, completely free, the metatarsals of the outer two closely bound together; discs large but not reaching size of discs on outer fingers, that on first toe smallest; a large projecting inner metatarsal tubercle; outer present but small; supernumerary tubercles present; subarticular tubercles distinct; a fairly distinct tuberclelike swelling immediately behind discs on both hands and feet; no trace of a web.

Skin above generally smooth with some minute granules in loreal region and behind eye; area about tympanum with small granules and larger tubercles; a supratympanic fold and a fold from back of orbit following the slightly elevated area of occiput, terminating on shoulders in an elongate tubercle; behind these and somewhat wider apart, another pair of tubercles; a single median tubercle in middle of occiput; axillary region and anterior two thirds of sides nearly uniformly granular; groin and under surface of femur and tibia smooth; chin and breast completely smooth; belly strongly and regularly granular; about half of median ventral portion of thighs and an area in anal region granular; posterior part of thigh smooth; a few low ridges follow the dim dark marks on tibia.

Color (in life): Generally yellowish clay, somewhat variegated above; head blackish, the sides similar to back, but becoming pink in smooth area of groin and anterior face of femur for half its length.

Posterior part of femur and part of tibia deep red; fingers whitish; legs olive, with dark olive-gray bars. Throat, breast and venter whitish with some very indistinct dusky shading; back part of rump a little dusky; limb bars dim; some dusky spots below eye; tip of snout dark; considerable pigment on under surface of foot, less under hand.

Measurements in mm. of Eleutherodactylus cerasinus

Collection	K.U.M.N.H.	K.U.M.N.H.	R.C.T.	U.S.N.M.
Sex	♀	♀	♂	
Number	28343	28342	538	32572
Snout to vent	33	32	21	35
Head length	14	14	8	13
Head width	12.7	12.2	7.9	13
Snout	5.4	5.4	4	..
Eye length	4.2	4.3	3.2	..
Greatest diameter of tympanum	1.6	1.6	1.1	..
Arm	19	18.2	11	22
Hand	8.5	9	5.3	9
Leg	50	50.2	34	55
Tibia	17	17.6	12.5	..
Foot and tarsus	22.8	23.2	15	24

Nos. 28342-28343, 538 Morehouse Finca, 5 mi. S Turrialba.

Variation: The colors vary somewhat, age presumably being a factor. In No. R.C.T. 357 the general color is yellow-brown above, and the reddish marks of groin and thigh are less distinct. There is no red present on tibia. The lighter areas on the sides are yellow or yellow-olive, while the head generally is darker. In R.C.T. No. 386, the specimen is "pinkish-brown above, whitish below; a pink spot on thigh." R.C.T. No. 356 "has a light, clay-colored, median stripe from occiput to groin."

In the preserved specimens the sides of the shoulders are darker and there are some dark spots on lips and a suggestion of a dark line along the edge of the canthus and tip of snout, a dark mark between orbits and one on base of snout. A pair of black tubercles may be present on the posterior part of the rump. In younger specimens the tubercles and folds are less distinctly marked. The males are very much smaller than females, the largest of several fully adult males being only 21 mm. These differ from females in the character of the first finger (bearing two groups of nuptial glands), and the tympanum is but little larger proportionally than it is in the females. A young male specimen (R.C.T. No. 385) has a pair of curving light lines beginning behind the eye and meeting on the middle line of the body, then continuing to the rump. On each side bordering this from the eye, is a black stripe. There is a deep-black median spot on occiput, an interorbital bar, a dark mark on the snout, darker lines on the upper edge of the canthi and several dark spots on the upper lip. The limbs are very distinctly barred.

The type specimen of *cerasinus* (U.S.N.M. No. 32572) is old and soft. Characteristic folds and tubercles of the skin are absent, and many characters cannot be determined. The heel reaches to a point just in front of the eye. The length of the eye (3.6 mm.) is about 3 times the tympanum (1.25 mm.). The specimen has no vocal slits but may be a female. There is a faint suggestion of web between first three toes which may be due to the condition of the specimen. The choanae are large, the anterior edge elevated (hangs down); vomerine tooth fasciculi elongate, triangular, much behind choanae but beginning anterior to their posterior edge.

The species was taken on the ground, at Morehouse Finca near Turrialba and at Boquete Camp, west slope of Cerro de la Muerte at approximately 2000 meters elevation. The type locality is on the eastern slope of Pico Blanco in southern Costa Rica. Dunn has reported the species at Zent, Costa Rica, from near sea level.

Eleutherodactylus dubitus sp. nov.

Figure 22

Type: K.U.M.N.H. No. 24942, Isla Bonita, (American Cinchona Plantation), Volcán Poás, southeastern slope, elev. 5500 ft.

Paratypes: K.U.M.N.H. Nos. 24910-24948. R.C.T. No. 1981, lot number for 53 specimens. All topotypes.

Diagnosis: Maximum size of female 38 mm., maximum of males 25 mm.; males without vocal sacs or vocal slits; fingers and toes without webs, long, slender, the discs twice or more the width of digits; tympanum minute about ⅙ diameter of eye; probably less than one twelfth of the area of the eye; venter and throat (usually) finely granular; color and markings variable.

Description of species: (From K.U.M.N.H. No. 24942). Width of head (15.2 mm.) approximately equal to its length (15.1 mm.); canthus distinct, rounded on edge; area about nostrils swollen but there is no noticable depression between them; eye moderately large, protuberant, the length of eye (4.9 mm.) less than length of snout (6.2 mm.); nostrils much nearer median notch in upper lip

FIG. 22. *Eleutherodactylus dubitus* sp. nov. Type. K.U.M.N.H. No. 24942; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 35.5 mm.

than to the eye; tympanum small, its diameter (1 mm.) approximately one fifth length of eye; width of an upper eyelid equal the interorbital width; tongue longer than wide, free for nearly half its length, not minutely emarginate behind; vomerine teeth in two transverse raised fasciculi each larger than a choanae, and separated from each other by a space nearly equal to width of one group; they lie considerably behind, but between the level of inner margin of choanae.

Skin smooth on dorsal surface with numerous smooth tubercles or small pustules on sides, especially in axillary regions and side of head near jaw angle; a tubercle between eyes; an indistinct W-shaped ridge marks a more elevated area on occiput; a slight supratympanic fold curves down to arm. Arms with large rounded tubercles on outer side; underside of thighs and venter uniformly granular, the chin only indistinctly granular.

Arm long, the wrist reaching considerably beyond snout tip; fingers free of web, long, slender, with discs, that on first smallest, those on third and fourth largest, nearly equal, the width (2.8 mm.) more than half length of eye; subarticular tubercles present, distinct; supernumerary tubercles on palm; a moderately large inner palmar tubercle at base of first finger; a bifid or tripartite median palmar tubercle; an indistinct row of tubercles under forearm; leg rather short the heel reaching slightly in front of eye; fingers long with a suggestion of narrow lateral ridges on each side of digits; terminal discs large but scarcely reaching size of those on fingers; metatarsals of two outer toes strongly united, the fifth toe extending beyond third. Small subarticular tubercles as well as supernumerary tubercles present on sole; a large inner metatarsal tubercle nearly half as long as first toe; outer tubercle small; a short metatarsal ridge from inner tubercle onto metatarsus ending in a tubercle; when legs are folded heels touch or minutely overlap.

Color: Ground color gray with dusky darker flecks and reticulations, the lateral folds of the W pattern edged with a narrow blackish line; some dorsolateral spots with diffused pigment; limbs very dimly barred, the lower part of posterior face of femur uniform brown away from anal area; below whitish with a fine dim reticulation of dusky; chin and breast lighter but with fine pigment; marks on side of head obsolete; a light area on heels; inner fingers light colored.

Measurements in mm. of Eleutherodactylus dubitus sp. nov.

	TYPE	24942 ♀	24933 ♀	24922 ♀	24913 ♂	24948 ♂	24918 ♂
Snout to vent	35	37.5	36	35.5	25	24	23
Head width	13	15.2	14.6	14.9	9.8	9.8	9.8
Head length	13	15.1	14	14	10	10	10
Arm	22	25	25	25	17	17	16
Hand	9	11	11	11	9	7.3	7.4
Leg	55	65	56	55	39	38.3	37
Tibia	17	17	18	18	13	12.8	12.6
Foot and tarsus	24	26	26	26	19	18.6	17

All numbered specimens from Isla Bonita, Costa Rica.

Variation: In this species there are several color patterns that are found occasionally so different as to make the beholder question whether the forms are the same. A few of the more striking types of pattern are listed.

1. The general pattern delineated above is characteristic of approximately 81 per cent of the specimens examined. There is, however, some variation in pattern, often a distinct lighter area appearing on the occiput. This is characteristic of both sexes.

2. A nearly uniform brownish black or blackish brown above with some slightly lighter areas sometimes visible; the venter is brown—the pigment heavy, the sides having large blackish spots with lighter interspaces. In life these may display some pink or reddish coloration in the thigh area or groin. This type of color occurs in both sexes. These constitute approximately ten per cent of the specimens.

3. In both dark and light forms the top of head and body is uniform clay-color; in lighter forms the sides are spotted. Six of these specimens have been seen, one clasping a female of the first group.

4. In these the body is relatively dark save for a symmetrical light clay-colored area beginning on snout and extending back on the elevated part of head bounded by the W-shaped folds. The light spot has two tiny symmetrical dark markings near the back of the head.

5. A median light stripe extends the length of the body. There is a tendency for the pigment to become arranged so as to show two darker stripes one on each side of the light stripe; three of the four specimens so marked are light, one is of the dark phase.

6. One very young specimen has two broad dorsolateral stripes. This specimen was taken at Cervantes.

Specimens for the most part were taken at night with the aid of a light. The males were calling from small shrubs or from the road-

cuts. It was, perhaps, the most common species at Isla Bonita during my visit there in 1947. Males are especially small compared with the females.

I cannot agree that this species should be referred to *Eleutherodactylus latidiscus*. This latter species, while agreeing in certain characters, i. e. the absence of the vocal sac, in the males, is a much larger species reaching a snout-to-vent length of 52 mm.; the ventral skin is smooth rather than granulate; and the tympanum is very much larger, one third to two fifths diameter of eye. The largest Costa Rican specimen of *dubitus* (female) in the large series available to me is only 38 mm. Any close relationship to *Eleutherodactylus ventrimarmoratus* is likewise doubtful. Here again the name applies to a species having a smooth venter. The marking of dorsum and thighs is distinctly different, and the tympanum is larger. I would suspect that *E. ventrimarmoratus* is more closely related to *Eleutherodactylus ceresinus* than to the form here described. (See Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, 1933, pp. 68-69.)

Eleutherodactylus noblei Barbour and Dunn

Figure 23

Eleutherodactylus noblei Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, pp. 161-162 (type locality Guápiles, Costa Rica, Dunn coll.).

This species perhaps doubtfully separable from *Eleutherodactylus lanciformis* (Cope) is represented by three specimens in the material at hand; two smaller examples are from Guápiles, the type locality for *noblei*, and one, a large adult, is from near Turrialba.

Diagnosis: A purplish-black stripe on side of head from tip of snout crosses tympanum, and continues, much narrowed, to middle of side; canthus distinct, rounded; no folds or distinct tubercles on body, except a straight dorsolateral fold from eye above tympanum continued to near groin, with a short diagonal branch running down behind tympanum; venter and throat smooth, the belly with a broad strongly defined discoidal fold; a sharply defined tarsal fold; legs long, heel extending several millimeters beyond tip of snout; hands without webs; some trace of webs on feet.

Description of species: (From K.U.M.N.H. No. 28172, Turrialba, C. R.) Head broader than body, its width (25.5 mm.) minutely greater than length (25 mm.); eye proportionally small, its length (6.2 mm.) approximately half length of snout (12 mm.); tympanum large, vertically oval, placed slightly diagonally (5.3 mm. x 3.6

mm.), separated from eye by a distance of 3.6 mm.; canthus distinct, rounded, but due to the sharp delineation of dorsal and lateral color it appears angular; area about nostril slightly swollen, the nostrils not terminal, 8 mm. from eye, 3 mm. from tip of snout and 5.2 mm. from median notch in upper lip; snout projecting beyond mouth 3 mm.; width of an upper eyelid (5.3 mm.) much less than inter-

FIG. 23. *Eleutherodactylus noblei* Barbour and Dunn. K.U.M.N.H. No. 28172; Turrialba, Costa Rica; snout-to-vent length, 60 mm.

orbital width (8.3 mm.); loreal region slightly concave, nearly vertical, the lower part sloping obliquely to lip.

Vomerine teeth in two series on triangular elevations between choanae and anterior to their posterior level, each series smaller than a choana; choanae lateral, when seen from below appearing oval; tongue longer than wide, a little wider posteriorly than anteriorly, distinctly emarginate behind, and free behind for one third of its length.

Arm long, wrist extending half length of forearm beyond snout; no webs on digits of hand; first finger longer than second, each with a narrow terminal disc; two outer fingers with discs at least one and one-half times larger; subarticular tubercles oval, moderately prominent; supernumerary tubercles indicated but indistinct; inner metacarpal tubercle oval, elongate, at base of first finger; median palmar tubercle a large pad, partly divided; no fold or tubercles on under surface of arm; leg long, the heel reaching about 8 mm. beyond tip of snout; heels overlap 8 mm. when legs are folded at right angles to body; a sharply defined, continuous, tarsal fold more than half length of tarsus; discs of toes smaller than those on fingers, that of first and fifth smaller than the other three, fourth largest, all more or less asymmetrical; subarticular tubercles prominent; five supernumerary tubercles on sole; inner metatarsal tubercle oval, elevated, more than a third length of first toe; outer tubercle small, distinct; third and fifth toes reach forward equal distances or the third slightly the longer; a small remnant of a web between the first and second toes extending as a very narrow fringe nearly half length of second; between second and third a still larger remnant, but web barely indicated between the third, fourth, and fifth; dorsal surface finely shagreened or granular; sides of body minutely but smoothly granular; a considerable part of under side of thigh granular, as is also anal area and to a lesser extent inner ventral part of thigh; the supratympanic fold, with a posttympanic branch, continues as a skin fold along side of body to groin; chin and venter smooth or transversely wrinkled, the ventral abdominal "disc" sharply outlined by a discoidal fold.

Color: Dorsal surfaces generally grayish mauve or lavender with a pair of curving stripes arising above tympanum, curving back to near the median dorsal line, then diverging slightly before they terminate; on the sacrum a pair of dorsolateral stripes begin back of shoulders and continue to groin; a moderately distinct darker bar across head in interorbital region preceded and followed by a similar but curving line; a pair of rounded dusky spots on middle of snout; arms and legs dimly barred with light brown, the lines curving somewhat or assuming the character of chevrons on the tibia; between these bars, very narrow intervening lines visible; posterior face of thigh uniformly dusky with minute flecks and lighter reticulations; darker lavender on under surface of tarsi and feet; entire venter and chin white with very slight pigmentation on chin; under side of hand nearly white; a hair-fine median dorsal

line. In life the general ground color is yellowish or yellowish brown with a pinkish wash on sides, on front of thigh, and on lighter parts of limbs.

Measurements in mm. of Eleutherodactylus noblei

Number collection	28172 ♀ K.U.	2077 ♀ R.C.T.	1563 ♀ R.C.T.	Type
Snout to vent	60	37	30	60
Head width	25.5	15.2	11.9	....
Head length	25	15.5	12.5	....
Snout (to eye)	12	7.6	5.8	....
Length of eye	6.2	4.6	4	....
Arm	44	24.5	17	....
Hand	19	12	9.5	....
Leg	114	69	49	105
Tibia	38.8	24	17.2	....
Foot and tarsus	50	31	22	....

Variation: The type is described as having a body wider than head, with the tibiotarsal articulation reaching nostril. The first difference is probably not significant in an adult female since the specimen I describe, if it were gravid, might well have a body broader than the head.

In the smallest topotypic specimen (No. 1563) the heel reaches the tip of the snout; the somewhat larger specimen (No. 2077) has the heel reaching five millimeters beyond the snout. The specimen described is from Turrialba; the others are from Los Diamantes, near Guápiles.

I have considered the possibility that *Eleutherodactylus noblei* might be a synonym of *Hylodes fitzingeri* O. Schmidt. The description of the latter is very brief and omits mention of many characters and proportions. Among the characters of *fitzingeri* mentioned by Schmidt that are not applicable to *noblei* are: very slender body; a white line around tip of snout and on to jaw (rather than a broad purple line of *noblei*), and proportionally longer leg; there is shown on the Schmidt figure (plate I, fig. 10), that the web-remnant reaches to or beyond the level of the basal subarticular tubercles. No mention is made of the dorsolateral fold from eye to side or the presence of a strong inner tarsal fold. *E. noblei* is a lowland form reaching a known elevation of 2000 ft.; *E. fitzingeri* is from 4000 ft. elevation.

Dunn [*] has described *Eleutherodactylus breederi* from Darien, said to be related both to *noblei* and *gollmeri*.

[*] Dunn, Amer. Mus. Novitates No. 747, 1934, pp. 1-2.

Eleutherodactylus gollmeri (Peters)

Figure 24

Hylodes gollmeri Peters, Monatsb. Akad. Wis. Berlin, 1863, p. 409 (type locality, Caracas, Venezuela, Gollmer coll. 2 specimens); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2 ed., 1882, p. 205 (Quito, Perú, and Sarayacú, Ecuador); Proc. Zool. Soc. London, vol. 2, Oct. 1, 1903, p. 69 (Chapadá, Matto Grosso, Brazil); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 464.

Hylodes güntheri Steindachner, Verh. Ges. Wien, vol. 14, 1864, p. 246, pl. 17, fig. 1, 1a. (type locality, Brazil).

Eleutherodactylus gollmeri Dunn, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, p. 24 (places *rostralis* Werner, *humeralis* Fowler, and *goldmani* Noble in synonymy); Occ. Papers Boston Soc. Nat. Hist., vol. 8, June 7, 1933, p. 67 (El Valle de Anton, Panamá.).

Lithodytes lanciformis Cope, Proc. Amer. Philos. Soc., 1877, p. 88 (type locality "West coast of Central America").

Hylodes lanciformis Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude sur les Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 55; Boulenger, Catalogue of the Batrachia Salientia. . . . 1882, p. 202; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 239; Nieden, Des Tierreich, Lief. 46, Anura I, 1923, p. 429; Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, pp. 161-162 (Navarro and Guápiles, Costa Rica).

Diagnosis: Medium-sized terrestrial frogs, maximum snout-to-vent length approximately 40 mm.; scarcely any sexual differentiation in size; snout rather narrow, the canthus sharply defined; a purplish black stripe from tip of snout covering side of head and to a point low on side; no vocal sac in male; a pair of black tubercles behind shoulders; subarticular tubercles large; small finger discs, larger ones on toes, all somewhat pointed with a tiny web remnant on foot.

Description of species: (From K.U.M.N.H. No. 30874, Moravia, Costa Rica.) Medium species (33 mm.) the snout rather bluntly pointed, oval; canthus distinct, the lines of canthi converging toward nostrils, then widening at nostrils; top of head and snout flattened somewhat without depression between nostrils; area about nostrils swollen slightly laterally; line of canthus continuous with thickened line bordering upper eyelid; tympanum large, edges elevated, 2.2 mm. wide, 2.5 mm. high; distance between tympanum and eye, 1.8 mm.; length of eye opening (4 mm.) equal to distance between eye and nostril (4 mm.); length of snout, 6 mm.; width of an eyelid (3 mm.), less than interorbital width (4.2 mm.); loreal region not concave, sloping regularly from canthus to lip; tongue slightly longer than wide, not or but slightly nicked behind; vomerine teeth in two raised fasciculi lying between inner levels of choanae but not reaching their posterior levels, separated from each other by half width of one fasciculus, and from the choanae by width of a fasciculus; ostia pharyngea triangular, but equally as large as choanae; (male without vocal sacs).

Arm short, the wrist reaches to tip of snout; first finger longer than second; no web between fingers; discs present but those on two inner fingers not wider than digits; outer somewhat wider, all more or less pointed at tips; subarticular tubercles prominent (less so than in *rhodopis*); six supernumerary tubercles on bases of fingers and palm; a prominent rather elongate inner metacarpal tubercle; palmar tubercle large, bifid, the outer part half size of inner part; several elongate tubercles under arm forming a broken ridge or fold; no webs on fingers but a ridge along inner edge of inner fingers.

FIG. 24. *Eleutherodactylus gollmeri* (Peters). K.U.M.N.H. No. 30874 Moravia, Costa Rica. Actual snout-to-vent length, 33 mm.

Leg very long, the leg brought forward, the heel reaches 6.5 mm. beyond tip of snout; when legs are folded, the heels overlap 5.5 mm.; toe discs larger than those on fingers, all more or less pointed; a web remnant between three inner toes, continued along inner edges of toes as a narrow fringe or ridge; a distinct, rather prominent, inner metatarsal tubercle; a small but distinct conical outer tubercle; a strongly defined inner tarsal fold along distal half of tarsus; a ridge along outer edge of fifth toe more or less continuous along outer edge of tarsus as a series of indistinct tubercles; third and fifth toes reach forward nearly an equal distance.

Skin above on dorsum, head and limbs, with some minute granulation and some somewhat larger tubercles; eyelid with small tubercles; a pair of larger tubercles (usually black) on dorsum behind level of arm insertions; thickened edge of eyelid continuous with a small but sharply defined supratympanic fold which terminates a little behind level of arm insertion; a curving supratympanic ridge visible in front and behind tympanum but coinciding with the fold above the tympanum; chin, breast, and venter smooth; some granulation on under and posterior part of thigh; a strong heel tubercle; a ventral disc outlined by a narrow fold terminating some distance in front of thighs; no inguinal gland discernible.

Color: Above brownish, with a dim darker pattern; head light brown above, black laterally; lines of canthi lighter, continued forward to lip as two narrow white lines; behind eye the whitish line follows above the black and terminates low on side behind arm insertion; a hair-fine median cream line; a dark triangular spot on occiput beginning between eyes; some dim diagonal lines on sides; a dim bar crossing rump; limbs strongly barred with darker brown and edged with lighter, the marks continuous when legs are folded, those on tibia arranged as chevrons; a black spot on each forearm, on thighs near knees, two at vent; blackish on underside of tarsus and foot, and a line on under surface of tibia; chin and venter cream to flesh-white, front of thighs somewhat pinkish; a fine scattering of pigment on chin; venter free of pigment.

Measurements in mm.: Snout to vent, 33; width of head, 14; length of head, from jaw angle, 15; length of arm, 22; leg, 69; tibia, 23; foot and tarsus, 34.

Variation: There is considerable variation in the darkness and lightness of the ground colors. Some specimens are light gray to fawn or clay, others deep brown; the dark color on the side of head (loreal region, below eye, tympanum and a stripe continuing down on side) is almost invariably the same. I have however found two specimens (7980 Chicago Natural History Museum, Suretka, C.R. and K.U.M.N.H. No. 30872, Moravia, C.R. that differ in this character. The black on the side of the head is broken into a series of discrete dark brown or black spots separated or bordered by clay white, that extend from the tip of the snout to behind tympanum. The Suretka specimen has the tarsal fold extending farther on tarsus than in the described specimen.

Remarks: Individuals were found in deep forest hopping about the forest floor in the daytime. There is no vocal sac in the male, and I am not aware of having heard them make any calls.

Specimens have been taken by me at Moravia (Caribbean drainage); Isla Bonita; Morehouse Finca, Turrialba; it is probably widely distributed in Costa Rica. I have not taken specimens above 5500 ft. elevation. It has been reported from Navarro and Guápiles.

Eleutherodactylus podiciferus (Cope)*

Figures 25, 26, 27, 28

Lithodytes podiciferus Cope, Journ. Acad. Nat. Sci. Philadelphia, new ser., vol. 8, 1875, pp. 107-108, pl. 23, fig. 9 (type locality, 5000-7000 feet elevation on Pico Blanco, eastern Costa Rica); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Hylodes podiciferus Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 56; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 203.

Lithodytes muricinus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 108-109, pl. 23, fig. 13 (type locality, Pico Blanco, eastern Costa Rica).

Hylodes muricinus Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 56; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 203.

Lithodytes muricinus muricinus Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Lithodytes muricinus habenatus Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Lithodytes rhodopis (*part.*) Cope, Proc. Amer. Philos. Soc., vol. 31, 1893 (Dec. 23), pp. 337-338.

Hylodes rhodopis (*part.*) Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug., 1900, pp. 232-233, pl. 67, fig. c, c'.

?Eleutherodactylus rhodopis Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Aug. 17, 1921, p. 161 (Camino del Río, Costa Rica).

?Eleutherodactylus blairi Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 29-30, pl. 3 (in color) (type locality Gutiérrez, Boca del Toro province, Panamá, near the Costa Rican frontier).

Lithodytes habenatus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 109 (type locality, Pico Blanco).

Hylodes habenatus Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 56; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 203 ("probably not different from *muricinus*").

Cope's early report (1875) on the William Gabb Collection, made chiefly at varying elevations on Pico Blanco, a high mountain in southern Costa Rica, named certain forms that would appear to belong to the species here considered. Unfortunately the preserved material was not in the best physical state when studied which may account for Cope's failure to comment on many of the salient features; and he may not have used adequate magnification to discern the less salient characters. His treatment consisted in naming and briefly characterizing three presumed species: *Lithodytes podiciferus*, with varieties A, B, C, and D; *Lithodytes muricinus*, and *Lithodytes habenatus*.

* *Eleutherodactylus podiciferus* (Cope), Amer. Philos. Soc., vol. 18, Aug. 11, 1879. The species reported from Tehuantepec. This reference was not considered by Smith and Taylor, "An annotated checklist and key to the Amphibia of Mexico," although mentioned by Taylor and Smith in an earlier work.

I have chosen the name *podiciferus* to stand for what I presume to be the single species involved because it has page preference and is somewhat better characterized than the two other names. Cope (1887) placed *habenatus* as a subspecies of *muricinus.* Later (1893) Cope placed *podiciferus, habenatus,* and *muricinus* in the synonymy of *Lithodytes rhodopis* Cope.

Subsequent writers treating forms of the species here considered under the name *Eleutherodactylus podiciferus* have presumed it to be identical with the Mexican species known as *Eleutherodactylus rhodopis* (Cope), whose type locality is "vicinity of Orizaba," Veracruz, and whose range reputedly extends southward through Central America to Brasil. I have seen no specimens of *E. rhodopis* from southern Central America, and I regard it as probable that specimens of the group treated here may have served as a basis for certain reports of the occurrence of *E. rhodopis* in Costa Rica

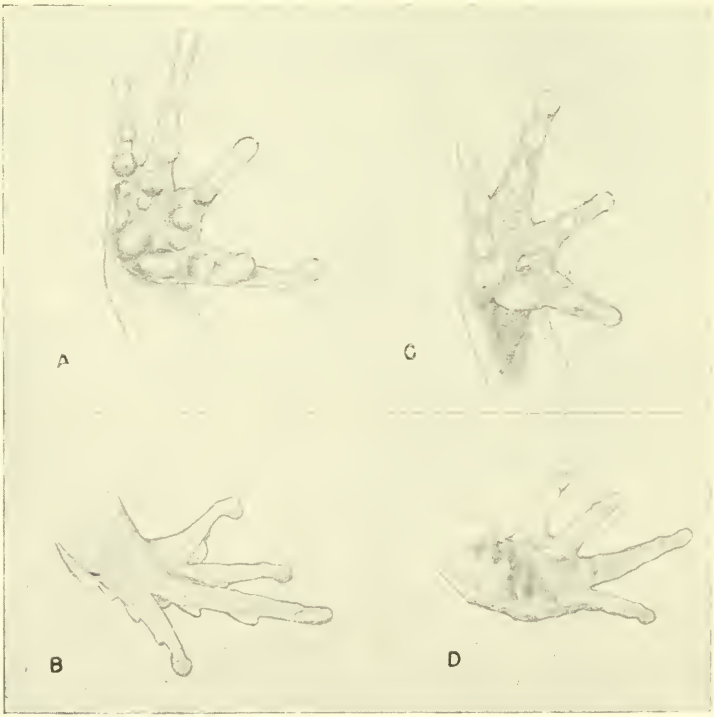

FIG. 25. *Eleutherodactylus rhodopis* Cope. Mexico. Fig. A, hand, ventral view; fig. B, hand, dorsal view. (Note length of digits and the projection of the subarticular tubercles.)

Eleutherodactylus podiciferus Cope. Fig. C, hand, ventral view; fig. D, hand, dorsal view.

and south and southeast of this country. Certainly none of the large series of specimens at hand (more than 100) of this variable group is *E. rhodopis*. Cope who finally accepted this synonymy had very poor and very meagre materials on which to base his judgment and perhaps was influenced in his action by other herpetologists who likewise, with very inadequate materials, regarded the Mexican and Costa Rican forms as synonyms. (See fig. 25.)

But having made certain that *E. rhodopis* is not involved here, one finds in Costa Rica within the limits of what is probably a single species such an extraordinary lot of inexplicable variation in structure and color pattern, that a number of species would appear to be involved. These may be segregated into groups, having the same general structural characters and the same general color patterns. That these groups do not represent distinct species or that more than a single species is involved, has not been proved. However, one reasons, that to have six or eight species of a single section of a genus occurring in the same locality without any significant change in body form or size, is rather unlikely. Most of the easily observable differences in these lots are those involving the dorsal folding and tuberculation of the skin; the relation of these folds to the color pattern variants; the tuberculation of the sole, palm, and underside of the digits; and the presence or absence of granulation of the venter. Thus the venter may be distinctly covered with granulations, may be partly covered or may be smooth; supernumerary tubercles sometimes approaching the size of the subarticular tubercles may be present or absent or variable in number. The development of symmetrical patterns of folds does not seem to follow a general over-all plan, as occurs to considerable extent in other species of *Eleutherodactylus*. In these segregated groups a certain general type of color pattern is usually associated with a particular arrangement of the dorsal folds and tubercles.

I have drawn up a somewhat detailed description of one form, K.U.M.N.H. No. 28283 representing one of the most distinctive variant groups; this is followed by a series of shorter descriptions of other variant forms dealing chiefly with color pattern and the disposition of dorsal folds, the tuberculation and granulation of the ventral surfaces; the shape of fingers and toes remain rather constant throughout. Only when adequate breeding experiments have been made will it be possible to determine whether or not the arrangement here given is tenable wholly or in part; and in its present form should be regarded as tentative.

Just how many major varieties of *podiciferus* occur in Costa Rica cannot be stated; but I strongly suspect that each separate zoogeographic province may have developed variations of its own, while certain provinces may have several forms in the same place. In the material available to Cope from Pico Blanco is one variety (var. C) that is not represented in my collections. There are certain ones in the collections at hand that may not be present on Pico Blanco. Because of the diversity of varieties it becomes a matter of difficulty to define the species as a whole. However the following will serve in some measure.

Diagnosis: Moderately small frogs their adult size rarely exceeding 34 mm. in length for females and probably 26 mm. represents a maximum for the males. Body above with long or short dermal tubercles and folds; a more or less distinct ridge on outer edge of eyelid continuous with the supratympanic fold, which continues in a straight line not bending down behind tympanum; inner tarsal folds represented by an indistinct short ridge or tubercle, the outer by a short ridge or tubercles; venter perfectly smooth or strongly granular with or without well-developed supernumerary tubercles on under surface of pes and manus; tympanum variable in the sexes but always distinctly below supratympanic fold (i. e. not partly covered by it); first and second fingers equal, but no grooves around their tips; choanae lateral; vomerine teeth in two transverse fasciculi, situated behind choanae, separated mesially by less than one third their length; vocal slits present situated near back level of tongue and near jaw angle; the tooth series consisting of 8 to 12 teeth in adults; heel to tip of snout or slightly beyond; subarticular tubercles usually low, large, rarely moundlike or biscuit-shaped (never strongly conical and forward pointing as in *rhodopis*); no trace or only a very indistinct trace of digital webs; digital discs present, those on fingers not wider than part of digit immediately behind them, those on toes variable, all at least slightly wider than the digit; inguinal gland minute or wanting; ventral disc if evident terminates anterior to thigh.

Diagnosis of variety: A small species (30 mm. ♀, 21 ♂). Tympanum large, not touching and not overhung by supratympanic fold, approximately three fourths of the length of eye; choanae small lateral; vomerine teeth in two large, slightly converging series behind choanae but between their inner levels; vocal sac and slits in males; tongue one-third free; a pair of dorsal folds, the area between and bordering them usually lavender to purple; heel to front of eye.

Description of species: (K.U.M.N.H. No. 28283.) Head rather short; the length of head (12 mm.) equal to width of head at the tympanum (12 mm.); canthi sharply defined, curving from eye to nostril; loreal region slightly concave, sloping obliquely to lip; areas about nostrils slightly swollen laterally, and a distinct depression between them on surface of snout; tip of snout rounding in profile, very slightly extended beyond lip (1 mm.); nostril closer to median lip-notch than to eye; tympanum of female, oval, the edges moderately defined, the height, 2.4 mm., the length, 1.8 mm.; separated from eye by a distance of 1.8 mm.; length of eye (3.1 mm.) minutely

FIG. 26. *Eleutherodactylus podiciferus* (Cope). K.U. M.N.H. No. 28283, Isla Bonita, Volcán Poás, Costa Rica. Actual snout-to-vent length 30 mm. (supratympanic folds are light colored but actually are more distinct than shown).

greater than distance to nostril (3 mm.), shorter than snout length (3.7 mm.); width of an eyelid (2.6 mm.) less than interorbital interval (3.2 mm.); distance between nostrils (3.7 mm.) equal to snout length.

Choanae small, widely separated, lateral, diameter of one in distance between them more than eight times; vomerine teeth in two elongate fasciculi, converging slightly, separated mesially by third length of a fasciculus, much behind but lying within inner level of choanae; tongue longer than wide, broadly rounding behind without emargination, much narrowed in front, free posteriorly for nearly a third of its length; (vocal sac and vocal slits present in

males very far back, behind tongue); ostia pharyngea much larger than choanae.

Arm with wrist reaching tip of snout; fingers short the first slightly shorter than second when laid side by side; the terminal discs not or but slightly wider than digit in females (distinctly wider in males), and the edges of the discs lack transverse grooves unless disc is slightly shrivelled or dried; no (or scarcely) trace of web on hand or foot; subarticular tubercles large, rather flat; an oval inner metacarpal tubercle one half length of first toe, and a larger rather elevated median palmar tubercle; faint indication of supernumerary tubercles; a row of three tubercles on under surface of arm, and a slight irregular ridge on the dorsal surface of arm.

Heel reaching beyond tip of snout; toe discs larger than finger discs, symmetrical, somewhat pointed oval in shape, all with a transverse groove, and without web; inner metatarsal tubercle oval, half length first toe; inner tarsal fold represented by a short ridge or tubercle some distance back of the inner metatarsal tubercle, while the outer tarsal tubercle is large, rounded, distinct; subarticular tubercles a little more elevated than those on hand; none, or but slight trace of supernumerary tubercles; an outer tarsal ridge or fold broken somewhat into a row of tubercles.

A pair of strong, slightly sinuous dorsal folds begin near eyelid and curve gently inward on the shoulders then turn again outward to reach their greatest separation on the sacrum, then suddenly curving in again only to turn out abruptly and terminate on sides of rump; a ridge across edge of eyelid continues straight with the supratympanic fold which runs diagonally to a point above arm insertion; a pair of short ridges or elongated tubercles somewhat anterior to outer edges of sacrum; sides strongly granular or tubercular, the granules sometimes tending to form longitudinal lines; dorsum with minute granulation or tuberculation; dorsal surface of limbs strongly granular and at points where the dark bands cross leg there is often a diagonal ridge or tubercles; chin and breast without granules; edges of the abdominal area with granules sometimes covering nearly half the area; abdominal disc not or only very faintly indicated; median and posterior parts of thigh granular.

Color: In life, dorsal coloration consists of a broad brownish-purple stripe covering top of head and occiput, narrowing on shoulders and continuing back to thigh level or end of rump, the color extending a little beyond lateral limits of the dorsal sinuous folds; this bordered laterally by a light tan stripe limited anteriorly

by the skin folds (supratympanic and dorsal); it continues back merging with the light tan coloration of the sides and rump (this light region may contain some purplish tubercles and brownish flecks); side of head purplish, becoming somewhat more intense from tympanum to tip of snout; from tympanum to back of arm insertion, below the supratemporal fold, somewhat brownish or purplish brown; arms and legs barred with purplish bands of greater or lesser intensity; venter and concealed surfaces with pigment, nearly uniformly distributed except on under side of tibia and a region on front inner face of thigh; a purplish triangular area on posterior face of thigh including anus; under side of tarsus and foot purplish.

Measurements in mm. of Eleutherodactylus podiciferus (Cope)

Museum numbers	K.U.M.N.H 28283 ♀	K.U.M.N.H. 28284 ♂
Snout to vent	30	21
Length of head	12	8.5
Width of head	12	9
Length of snout	3.7	3
Length of eye	3.1	2.8
Tympanum height	2.4	2.3
Tympanum length	1.8	2
Arm	18	11
Hand	8	5
Leg	41	24
Tibia	18.4	12.2
Tarsus and foot	24	15.5

Variation: The specimens examined are K.U.M.N.H. Nos. 28283, 28284, 28285; R.C.T. 1587, 1662, 1743, 2353, 2651, from Isla Bonita.

The chief differences observable are, I believe, sex differences, the males having somewhat rougher tuberculation, much larger tympanum, and in larger males relatively larger digital discs, with the purple on side of head less intense. The supernumerary tubercles may be dimly present.

The color pattern is maintained, save that the young specimens have the contrast between the light and dark parts of the pattern much greater, and the banding of limbs is less intense. A faint ridge behind the tympanum may be indicated and there are two tubercles behind lower level of tympanum. In males the lower edge of the tympanum is nearly on a level with commisure of the mouth. The vocal slits are short and far back, usually beginning near back level of tongue. In younger specimens the rows of vomerine teeth are shorter with fewer teeth (10-12 teeth in adults).

This form resembles somewhat *Eleutherodactylus venustus* of Mexico in general habitus and in markings but differs in the character of the hand and foot, the first finger being distinctly shorter than second instead of considerably longer; the tympanum usually a fourth of its diameter below supratympanic fold instead of touching the same; the vocal slits are short (not partly covered by a skin fold); the terminal discs are distinctly larger and the supernumerary and subarticular tubercles are smaller and less elevated (the supernumerary tubercles are barely indicated in the female of the Costa Rican form); the tooth rows are transverse elongate instead of narrow and diagonal as in *E. venustus.*

"*podiciferus*" form

Figure 27

Probably the form that approaches most closely to the figured specimen of *Lithodytes podiciferus* (U.S.N.M. No. 30675) is K.U.M.N.H. No. 28259 from Isla Bonita. This specimen is generally clay or fawn colored with a pair of narrow, nearly parallel ridges beginning on the snout and continuing on to rump. There is a weak fold beginning some distance behind the eye running back dorsolaterally and somewhat irregularly to a point beyond the middle of body. There is a fold or ridge across the edge of the

FIG. 27. *Eleutherodactylus podiciferus* (Cope). K.U.M.N.H. No. 28259, Isla Bonita (American Cinchona Plantation) Volcán Poás, Costa Rica. Actual snout-vent length, 34 mm. This is the variety similar to the typical form named by Cope, *podociferus.*

eyelid that continues on above tympanum not turning down behind tympanum but continuing back in a straight line; the legs are barred with brown and the surface bears a few larger tubercles on the bands; the dark coloration on the side of the head and snout is purplish but behind the tympanum it tends to run down to venter. On the side its upper edge forms a diagonal line. There is very little granulation evident above, but under a lens a very fine granulation is discernible. The sides have small granular tubercles and the outer part of the abdominal region is distinctly granular, while the remainder of abdomen as well as breast, chin and throat are smooth. There is a hair-fine median light line on dorsum and a white line on the back of the thighs that is usually distinct. This specimen has the vomerine teeth in two very elongate transverse series, closely approximated mesially and extending out beyond the inner level of the choanae. The head seems to be narrower in this form in comparison with the length of the body. There is less pigment on the under surface of the feet than is usual.

The following specimens of this color form are available: K.U. M.N.H. Nos. 28259-28264; R.C.T. 1596, 1647, 1656, all from Isla Bonita, Volcán Poás.

"*muricinus*" form

Figure 28

This form which is similar to Cope's *Hylodes muricinus* assumes some variety in the details of the color patterns but in all of the specimens there is a dorsal area nearly uniformly colored in lavender, pinkish, purplish or clay from snout to end of rump. This color is bordered laterally by the dark purplish or black color of the side of the snout and head. Behind the tympanum a diagonal lighter stripe from groin pushes up and joins the dorsal color. Beginning behind the shoulder is a strong fold on each side, separated anteriorly by a distance of 7 mm. At first the folds are slightly sinuous. They converge gradually onto the rump where they are separated by a least distance of 4 mm. They again turn outward and become thickened just as they terminate. About midway on the side of the fold is a small branch running down and back for a short distance. The canthus is distinct and continuous with a ridge that passes over the edge of the eyelid and continues back from eye above tympanum, running diagonally. The tympanum which does not reach upper level of this fold, has a diameter (2.65 mm.) less than the length of the eye opening (3 mm.); the width of the eyelid (2.5 mm.) is much less than interorbital width (3.9 mm.); there are continuous ridges across the tibia, deep black

FIG. 28. *Eleutherodactylus podiciferus* (Cope). K.U.M.N.H. No. 31071, National Park, on Pan-American Highway above Empalme. Actual snout-vent length, 29.5 mm. This form is similar to that variety named by Cope, *muricinus*.

in color, and when leg is folded they are more or less continuous with smaller ridges on the thigh. The venter is more or less granular. This pattern is figured (see fig. 27).

This specimen figured has the following dimensions:

Measurements in mm.: Snout to vent, 29.5; width of head, 12; length of head to behind jaw angle, 12.1; arm, 17; hand, 7; leg, 55; tibia, 18; foot and tarsus, 14. The figure presented No. 31071 gives a reasonably good illustration of the form. Seven specimens referred to this form are K.U.M.N.H. Nos. 31043-31046 from the National Park on the Pan-American Highway on the way to Cerro de la Muerte; and R.C.T. Nos. 1778, 1792 from Isla Bonita, Volcán Poás.

"podiciferus var, B"

The specimens in this lot have the dorsal folds arising near the eyelid running diagonally back and mesially until they are narrowly separated (2 mm.); from here the folds diverge and continue back, curving around the sacral dilation and again converging somewhat, terminating on the rump in two slightly thickened ridges, not approaching within 6 mm. of each other in large adults. There is

only a trace of an outer fold in some, in others a small lateral fold is evident. The supratympanic fold is strongly defined in all.

Three of the specimens are dark, blackish; two, generally grayish or grayish brown above, all have an irregular whitish bar from the corner of the eye diagonally across the tympanum and on to the base of the arm. The bright rufous spot mentioned by Cope is not present, the side of the snout being blackish (red may have been present in life). One specimen, the largest female, has a hair-fine median line. The gray specimens are lighter on the ventral surfaces, there being some pink color on the thighs; the darker specimens have more pigment on the ventral surfaces; the large triangular area on back of thighs has no white lines. The venter is without granulation; subarticular tubercles are low, rather large, the supernumerary tubercles not or slightly indicated. The two largest specimens measure 32 mm. from snout to vent.

Specimens having these characters are K.U.M.N.H. Nos. 31059-31064. All are from the National Park.

"*habenatus* var."

Several specimens in the collection agree with the form named by Cope, *Lithodytes habenatus* from Pico Blanco.

There are eight specimens with a broad light stripe from eye continued back to groin and on to the base of the thigh. This may be flesh white or pinkish in color. The dorsum is indefinitely varigated in brown, gray or blackish, the hind limbs being lighter than the body and barred with darker color. The venter is flesh white, with a scattering of pigment (in one case very heavily pigmented). Folds on the back are the same as those in variety B, the lateral fold being distinct in part of the specimens and indistinct in others. One of the lot has a fine median light stripe and a white line crossing the thighs. The two largest specimens measure 33 and 35 mm., respectively. Specimens referred to the "habenatus" variety are K.U.M.N.H. Nos. 31047-31054. These are from the National Park area on the Pan American Highway, on the road to Cerro de la Muerte. A second lot consists of K.U.M.N.H. Nos. 31055-31058 and R.C.T. 1650, 1661, 1674 from Isla Bonita, Volcán Poás.

There are several minor color varieties in specimens having similar arrangements of the dorsal folds as in the *habenatus* variety. Nos. 3758, 5689, 5698, 5711 from the National Park have the ridges all dark colored on the dorsum, with a dark interorbital bar and a tiny cross bar behind the shoulders, connecting the two dorsal folds

at the point of narrowest separation. Two of the specimens are nearly pigmentless below; two have much pigment on venter.

A second variety from the National Park differs in having the two dorsal folds begin some distance back from the eye, converging for a distance then diverging, with the two short lateral folds connected with them anteriorly and curving out. There are three light spots, one mesial, two others lateral to it, more or less clearly defined on or somewhat behind the shoulders.

The following specimens are of this variety: K.U.M.N.H. Nos. 31065-31070, all from the National Park. Among the specimens from the National Park and surroundings are 53 that do not fall clearly into any particular color pattern heretofore listed. Their dorsal folds are placed in the general "hour-glass" arrangement.

From Isla Bonita there are some 91 specimens that are rather uniform in general characters. The dorsal folds enclose the hour-glass area on dorsum, there are two dark spots on the back where the lines are closest together and another pair on the rump. The side of the head is usually uniformly dark but occasional specimens have light areas separated by darker areas in the loreal region and below the eye. These specimens are small, all under 28 mm. in length. K.U.M.N.H. Nos. 28290-28335, 28411-28431, from Isla Bonita and a similar series present in the R.C.T. collection are of this variety.

Quite similar to these save in ventral granulation and tuberculation is a series from Isla Bonita 28398, 28402-28408, 28410, and a smaller series K.U.M.N.H. Nos. 28395-28397, 28409, from Boquete Camp on the west slope of Cerro de la Muerte.

In these the greater part of the abdomen is strongly granular; the subarticular tubercles are very large (but never pyramidal or conical) and supernumerary tubercles are well developed on the hands and feet. There is a series from those localities represented in the R.C.T. collection. The dorsal characteristics of these two latter groups are not uniform, however they do not seem to fall clearly into major varieties mentioned heretofore.

Eleutherodactylus melanostictus (Cope)

Lithodytes melanostictus Cope, Journ. Acad. Nat. Sci. Philadelphia, N.S., vol. 8, 1876 (1875), pp. 109-110, pl. 23, fig. 10 (type locality, Eastern Costa Rica, 7000 ft. elevation on Pico Blanco; W. W. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Hylodes melanostictus Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1 and 2, 1881-1882, pp. 56-57; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the British Museaum, 2nd ed., 1882, p. 210; Günther, Biologia

Centrali-Americana; Reptilia and Batrachia, 1900, p. 224, pl. 65, fig. A; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 428-429 (places *L. engytympanum* in synonymy).

? *Eleutherodactylus p. engytympanum* Dunn, (*part.*), Acad. Nat. Sci. Philadelphia, vol. 92, 1940 (Nov. 18), p. 108 (considers *fleischmanni, euryglossus, engytympanum* and *pittieri* as conspecific with *Eleutherodactylus punctariolus*).

Diagnosis: Head rather short; body rather elongate; vomerine teeth in widely separate series; not extending beyond inner level of the choanae; ostia pharyngea and choanae of about same size; tongue sub-round, one third free; canthi rostrales straight, convergent; diameter of eye equals distance between eye and nostril; tympanum narrow vertical oval one fourth eye; finger discs larger than those on toes; skin smooth; first finger shorter than second.

Description of species: (From Cope *loc. cit.*). "A species of distinct type from the preceding [*habenatus*] in its short head and longer body. Size of *Rana temporaria.* The vomerine teeth are in two short transverse series entirely behind the inner nares, well separated from each other and not extended outwards beyond the line of the inner margin of the nares. Choanae and ostia pharyngea sub-equal; tongue sub-round, one-third free, and a little emarginate behind. Head flat, wide, muzzle projecting a little, canthus rostrales straight convergent. Nostrils more than twice as far from orbits as from end of muzzle; their distance apart 1.33 times in their distance from the orbit. Loreal region and lip oblique. Diameter of eye equal distance from its border to the nostril, its area four times that of the membranum tympani, which is a rather narrow vertical oval. Skin everywhere smooth. Limbs long, dilatations of fingers large, of toes moderate. The muzzle marks the middle of the cubitus and a little beyond the middle of the tibia. The order of lengths of the fingers is, 1-2-4-3; first and third toes equal. The sternum is a wide cartilaginous shield notched at the end. There is a well-developed zygomatic process of the squamosal bone, but no corresponding malar process.

Color: "Ground-color above, brownish-gray; below, dirty-white. The limbs are cross-banded rather distantly with blackish, the bars extending on the front and back faces of the femur as well as on the upper surfaces. A white median band from muzzle to vent, which is bounded on the sides at different points with blackish. A pink band extends from above the tympanum to the end of the ilium and is broadly bordered with black on the outer side, this color extending on the sides of the animal as oblique black spots. The tympanum is black and sends a black bar to the rictus oris; two

black bars pass directly from the orbit to the lip, and another by the canthus rostralis and nares to the same.

One specimen from 7000 feet elevation on the Pico Blanco.

Measurements in mm.: "Length of head and body, 50; length of head to angle of jaw (axial), 15; width of head at angle of jaws, 22; length to orbit (oblique), 7; length to axilla, 19; width of sacrum, 9; length of fore limb, 37; length of fore foot, 19; length of hind limb, 96; length of hind foot, 45."

Remarks: I have not identified this species in the collections. It may be confined to Pico Blanco and the high peaks of the Talamanca Range.

Eleutherodactylus rugosus (Peters)

Figure 29

Hylodes rugosus Peters, Monatsb. Akad. Wiss. Berlin, 1873, pp. 610-611 (type locality, Chiriquí, Panamá, length 21 mm.); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed. 1882, p. 205; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug. 1900, p. 233 (Nicaragua); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 432 (Nicaragua, Panamá); Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, pp. 329-331 (places *Lithodytes megacephalus* Cope in synonymy).

Lithodytes megacephalus Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 110-111, pl. 23, fig. 11, 11a (type locality, Pico Blanco, Costa Rica, 6000 ft. elevation; W. W. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 16.

Hylodes megacephalus Brocchi, Mission Scientifique au Mexique. . . . Étude des Batraciens de l'Amérique Centrale, livr. 2, 1882, p. 57; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, pp. 210-211; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1901, p. 239 (Las Delicias and Santa Clara, 500 m. elevation, Costa Rica); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 436-437, fig. 319.

? *Lithodytes pelviculus* Cope, Proc. Amer. Philos. Soc., 1877, vol. 17, p. 89 (type locality, "west coast of Central America"); and U. S. Nat. Mus. Bull. 32, 1887, p. 16.

? *Lithodytes gulosus* Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 112 (type locality, Pico Blanco, Costa Rica; 6000 ft. elevation, W. W. Gabb, coll.).

Hylodes gulosus Boulenger (*loc. cit.*), p. 211; Günther (*loc. cit.*), p. 240; Nieden (*loc. cit.*), p. 437.

Eleutherodactylus rugosus Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, 1921, p. 161 (Monteverde).

Diagnosis: Body curiously toadlike; head very broad, the back rugose, bearing bony ridges, which pass back from orbits and form a pair of curving lines on anterior part of back; these are not continuous with plicae (or lines of tubercles) that originate in groin and diverge along sides of body to sacrum; venter cream, heavily reticulated with black or brown; digits small, the discs scarcely widened; length 103 mm.

Description of species: (K.U.M.N.H. No. 28176 ♂, Morehouse Finca, 4½ mi. S Turrialba.) Body squat, toadlike, head much wider than body with a pair of parallel bony crests beginning between orbits at their anterior level, in contact with inner edge of eyelid, extending some distance on occiput, posterior ends tending to turn mesially; area between crests depressed; snout flat; canthus rostralis distinct, angular or nearly so, terminating above nostrils; area about

FIG. 29. *Eleutherodactylus rugosus* (Peters). K.U.M.N.H. No. 21175; Isla Bonita, Volcán Poás, Costa Rica; snout-to-vent length, 29 mm.

nostrils slightly swollen with a slight depression between them and from their anterior level snout slopes abruptly down to lip; snout not projecting beyond line of mouth; loreal region concave, jaw-rim spread much beyond outline of snout; eye moderately prominent, its length (4.8 mm.) a little greater than its distance to nostril (4.1 mm.); length of snout 6 mm.; tympanum of male very large, subcircular, its diameter (4.2 mm.) a little smaller than length of eye; length of head (16.8 mm.) practically equal to its width (17 mm.);

width of an eyelid (5.2 mm.) a little less than interorbital distance (measured from outer edges of crests).

Choanae moderate, the plane of openings somewhat vertical to that of palate and vomerine teeth; latter in two somewhat triangular, elevated fasciculi, each bearing six teeth in transverse rows, narrowly separated medially, lying between inner level of choanae and considerably behind them, the elevated areas failing to reach their posterior levels; openings of Eustachian tubes larger than choanae; tongue somewhat cordiform, save that posterior emargination is slight or absent, free for about one third of its length.

Arms short; fingers small, the first distinctly longer than second or fourth; discs on fingers small, that on second finger smaller than others; a distinct groove is present at edge of discs; subarticular tubercles well developed, supernumerary tubercles (five or six) on palm indistinct; a large, elongate, metacarpal tubercle at base of first finger; palmar very large, bifid; two tubercles on under surface of arm, partially connected with a low ridge or indistinct tubercles; dorsal surface of arm with numerous rough tubercles.

Legs rather long proportionally, the heel reaching to nostril; discs on toes a little larger than those on fingers, largest about one fourth diameter of tympanum; those of outer and inner toe, smallest; subarticular tubercles moderately strong, no supernumerary tubercles; inner metatarsal tubercle large, oval, elongate, more than half length of first toe; outer tubercle relatively large, low; along outer side of foot and tarsus a low short indistinct inner tarsal ridge or fold; outer tarsal fold represented by several tubercles continuing from outer edge of foot.

Skin of head minutely tubercular with some large tubercles intermixed; eyelid with numerous rather large tubercles; a large irregular wartlike elevation above tympanum from which arises a skinfold that passes back toward middle line, terminating in front of the sacrum; skinfolds, beaded with tubercles, arise far back on rump and run forward diverging and terminating on outer edge of sacrum; a small ridge runs toward groin from posterior end of fold; skin of back and sides with very numerous granular tubercles and larger conical tubercles; legs covered with tubercles, the largest forming rows that cross femur and tibia where darker color bars cross them; venter and chin smooth; much of under part of thighs and area under vent with large, flat, smooth granules.

Color in life: Olive to brown-olive above with a faintly lighter area in interorbital region followed by a very dim transverse bar;

two slightly lighter stripes bordering external edge of body skinfolds, folds themselves rather black-edged on outer side; some very small black spots and silver spots border lower edge of eye; a narrow black line follows the supratympanic fold to behind tympanum, widening to cover upper half of tympanum; a black rump-spot following skinfolds; sides yellowish clay with a scattering of dusky olive; venter cream, the chin and throat clouded with dusky; venter and front of thighs cream, reticulated with intense black; thigh and tibia dimly barred above; intense black on lower posterior part of femur, the upper border of which bears cream spots; ventral part of thighs black with a few of the granules cream; under side of hand orange, especially digit tips, with some dusky markings; under side of foot black, the tips of digits orange; under side of tibia black, with cream spots.

Measurements in mm.: Snout to vent, 33; length of head, 16.8; width of head, 17; length of eye, 4.8; diameter of tympanum, 4.2; length of snout, 6; arm, 23; hand, 10; leg, 57; tibia, 19; tarsus and foot, 26.

Remarks: The synonymy given suggests that some confusion exists with regard to this species. The characteristics suggest generic differences from *Eleutherodactylus* and of the forms described, *rugosus, megacephalus, gulosus* and *pelviculus* all or part may represent recognizable forms. Cope believed that two forms *gulosus* (103 mm. in length) and *megacephalus* (70 mm. in length) occurred together on Pico Blanco in Costa Rica. The forms *rugosus* from Panamá (21 mm. in length) and *pelviculus* (less than half the linear dimensions of *megacephalus*) from an unknown locality "said to have been found on the west coast of Central America," shows certain differences from the larger female specimens, but whether these are actual differences or changes due to age or sex cannot be determined at the moment.

I have examined the types of Cope's Costa Rican *megacephalus* and *gulosus,* and owing to the condition of the specimens and absence of young, I could not prove beyond question the synonymy of these forms. Noble (*loc. cit.*), who studied specimens from Nicaragua was convinced that this material and the Pico Blanco, Costa Rican specimens were the same species. Only further collections from Pico Blanco of the supposed forms can settle the matter beyond doubt.

The ovarian eggs are 4 mm. in diameter suggesting that this species like many other *Eleutherodactylus* have omitted the free swimming larval stage.

Specimens in the collections at hand were taken in the forest at the Morehouse Finca four to five miles south of Turrialba. Two specimens were taken at Isla Bonita on the eastern slope of Volcán Poás at an elevation of approximately 5500 ft. The specimens were found moving about during the day on the forest floor. Occasionally they were routed out from under debris or small stones.

Since the preceding notes were written, I have obtained from Prof. Marco Tullio Pacheco, (K.U.M.N.H. No. 30771) a large specimen from near Turrialba (between Turrialba and the Morehouse Finca) that has the following characteristics: snout to vent, 65 mm.; hind leg, 95 mm.; head width, 34 mm.; head length, 25.6 mm. Fingers and toes free; small digital discs; leg brought forward the heel reaches to near front end of eye, the heels do not touch when legs are folded; a strong compressed inner metatarsal tubercle. The cranial crests begin at anterior level of the eye and continue to back of occiput, reaching their highest elevation and closest approximation at this point; two narrow lines beginning behind the strong supratemporal ridges curve back and in from shoulder, then curve outward to ends of sacrum from which point they can be traced back dimly converging to near end of rump.

First finger longer than second; tympanum vertically oval (5.2 mm. x 3 mm.); eye length, 8 mm.; eye to tympanum, 3.8 mm.; eye to nostril, 7 mm.

The vomerine teeth are in two triangular fasciculi lying partly between, but extending behind posterior level of choanae, and each considerably larger than a choana. The teeth are in slightly diagonal rows, converging mesially; ostia pharyngea distinctly larger than choanae. Canthus distinct not concave; a ridge from eyelid edge continuous with supratympanic ridge, which terminates in a slight boss directed inward.

Above, purplish black, with one still darker spot or band crossing thigh. Chin, breast, and sides finely reticulated with purplish lavender; center of venter cream with heavy blackish reticulation; back of thighs dark with some lavender mottling; ventral part of thigh, except distally, deep purple; front of thighs, under side of tibia and inner dorsal surface of foot coarsely reticulated, spotted or barred with purplish on a lighter ground.

The type of Cope's *Lithodytes megacephalus* has the cranial crests beginning considerably in front of eye.

The skin in Cope's specimen is smooth but this has considerable granulation on back, less on sides, and a few small flat granules or tubercles on chin; thigh below granular.

Eleutherodactylus ranoides (Cope)

Figure 30

Lithodytes ranoides Cope, Proc. Amer. Philos. Soc., vol. 23, no. 122, Apr. 1886, p. 275 (type locality, Nicaragua, J. F. Bransford, Coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 16.
Liohyla ranoides Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 335-336 (Terraba and "Buenos Ayres," Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1900, p. 225.
Hylodes ranoides Nieden, Das Tierreich, Lief. 46, Anura I, p. 431.
[Eleutherodactylus] ranoides Dunn, Proc. Acad. Nat. Sci., Philadelphia, vol. 92, 1940, p. 109.
Eleutherodactylus ranoides Barbour, Occ. Papers Mus. Zool. Univ. Michigan, no. 129, Jan. 25, 1923, p. 10 (Panamá).

Diagnosis: This species is represented in both collections by numerous specimens. It is variable in pattern but it may be identified by the following characters: a medium-sized species (females, three largest, 47-50; males, three largest, 30-32); having the same general appearance of *Eleutherodactylus crassidigitus* but legs distinctly shorter, the toes about one-fourth (or less) webbed; discs of two inner toes smaller than those of two outer; first finger in males thickened but distinctly less so than in *crassidigitus;* first finger longer and larger than second; toe discs equal or nearly equal to outer finger discs; heel reaches to tip of snout, or slightly beyond; a broad W-shaped mark often present and often a broad median

FIG. 30. *Eleutherodactylus ranoides* (Cope). K.U.M.N.H. No. 28375, Turrialba, Costa Rica. Actual snout-to-vent length, 46 mm.

light tan stripe; front of thigh marbled; back of thigh black or dusky enclosing cream-yellow spots; two small occipital folds; greatest diameter of tympanum of female three fifths length of eye; in male five sixths of eye length; six tubercles cross the back (in a curved row), the median pair less distinct, vocal slits in male.

Description: (From K.U.M.N.H. No. 28375, Turrialba, Costa Rica.) Snout rather narrowly oval; the width of the head (16.5 mm.) slightly less than head length (17.2); canthus rostralis present, rather rounded; loreal region vertical in upper part then sloping obliquely to lip; area about nostrils not or but slightly swollen, a slight depression between them and in front of them on tip of snout; snout projecting beyond lip 2 mm.; eye length (5.1 mm.) equal to or minutely less than distance of eye from nostril; length of snout 8.6 mm.; tympanum vertically oval (often nearly round or in males longer than high), its greatest vertical diameter (3.65 mm.) about .7 of eye length; a diagonal supratympanic fold (slightly curved or not) terminates above arm; a large multiple tubercle between tympanum and arm insertion; width of an upper eyelid, when flattened (4 mm.), a little less than interorbital distance (4.3 mm.); distance between nostrils, 4.6 mm.

Choanae largely lateral, the distance between them 4.5 mm.; vomerine teeth in two large triangular elevated fascicles, the anterior apex reaching to near level of middle of choanae and extending outward to near inner level, the tooth row much posterior to choanae but not behind the transverse palatal ridges; tongue somewhat oval, wider posteriorly and slightly emarginate behind, free for little more than one fourth of its length; male with elongate vocal slits, the vocal sacs forming indistinct folds at the sides of the angle of jaw.

Arm short, the wrist reaching tip of snout; first finger a little longer than second, the discs of the first two fingers small, equal in width; discs on two outer fingers larger, somewhat truncate, 2 mm. wide; subarticular tubercles large, rounded, elevated; supernumerary tubercles indicated but indistinct; a strong metacarpal tubercle at base of first finger, its length equal to a little less than half length of digit beyond tubercle; palmar tubercle large, partly bifid; no row of tubercles under arm.

Leg brought forward, the heel reaching tip of snout (rarely very slightly beyond); remnant of web between inner fingers about one fourth length of digit, not reaching anterior level of the proximal subarticular tubercles; between third and fourth and fourth and fifth approximately a fifth (or slightly less) webbed; (these remnants scarcely visible unless digits are spread); discs increasing in size to fourth (1.8 mm.), the fifth smallest; subarticular tubercles

distinct; no supernumerary tubercles on sole; inner metatarsal tubercle elongate, oval, half length of inner toe; outer tubercle rather large, round low; a distinct elongate inner tarsal fold, no trace of an outer fold.

A pair of indistinct, discontinuous folds beginning back of orbit and continuing back to middle of scapular region; some low tubercles across back representing three pairs, one mesial, one dorsolateral and one lateral (often marked by black spots); on sides there are traces of two tubercular folds or an indistinct linear series of tubercles; back with numerous smooth, small, low tubercles; sides with more or less distinct, irregular granulation encroaching slightly on the ventral disc; chin, breast, venter, front face of femur, groin, and outer posterior face of thigh shining smooth; granular on much of under surface of thigh as well as about anal region; dorsal surface of thigh slightly rough; that of tibia smooth.

Color: (In alcohol.) A butterfly-shaped mark in interorbital region, the design edged with black; in front of this, light brown, with an irregular transverse mark, and farther forward on tip another irregular spot; on occiput a rather broad W-shaped mark; behind this on back some indefinite marks present mesially; in scapular region a few small deep black spots; lip with four dusky marks separated by lighter color. Arms and legs banded indistinctly above; posterior face of femur blackish enclosing small cream spots or reticulations; venter flesh with some dusky pigment often forming small flecks on ventral surfaces; a more or less distinct longitudinal white stripe on chin; foot and tarsus purplish, the hand lighter.

Measurements in mm. of Eleutherodactylus ranoides

Locality	La Suiza	San Isidro El General	Turrialba	Turrialba
Number (K.U.M.N.H.)	28375	28384	28382	28379
Sex	♀	♀	♂	♂
Snout to vent	46	47.5	30	32
Width of head	16.5	18	10	12
Length of head	17.2	18	12	14
Length of snout	8.6	9	5.6	5.5
Length of eye	5.1	5.8	3.7	4
Height of tympanum	3.65	3.4	2.8	2.9
Length of tympanum	3	3.2	3.2	3.4
Arm	29	28	17.3	17.3
Hand	13	14	8.8	8.8
Leg	79	79	49	54
Tibia	27	29	17	18.3
Foot and tarsus	38	38	22	24.5

Remarks: Variation in color and markings is great but in no case does it seem to be geographic and the same types of variants occur in various localities.

The more striking color varieties are: K.U.M.N.H. No. 28383 ♀ (gravid) "Nearly uniform yellow olive above; chin and breast white; black and cream yellow spots on back of thigh; groin and limbs greenish yellow." In preservative light gray-lavender with faint W-shaped mark; other marks faintly visible. Reticulation on back of limbs strongly marked. A male of normal coloration was taken at the same time at Turrialba.

K.U.M.N.H. Nos. 28384, 28386, San Isidro El General; Nos. 28380, 28389, Isla Bonita; R.C.T. No. 479, Turrialba, Nos. 611, 2062, Isla Bonita, No. 1524 Los Diamantes. This series of specimens has a broad regular light tan or fawn stripe from tip of snout to vent, widening somewhat between anterior part of orbits and on snout; this is bordered by a dim dusky stripe; this in turn is bordered laterally by a lighter stripe, with another indefinite dusky stripe dorsolaterally; side of snout lavender, spotting obsolete on tip; tubercles and skin folds sometimes black-edged; in No. 28384 particularly the skin bordering the fawn stripe is elevated into a flat ridge, and the other ridges and tubercles seem a little rougher. No. 479 has the back very rough and pustular with an indistinct fold along borders of the fawn stripe; sides very granular with intermixed pustules. The heels may be of a lighter fawn color.

The constant characters of marking are: the light line on chin, the dark or black color of the posterior part of the thigh enclosing cream spots, or the region reticulated black and cream.

Specimens were found under rocks along rivulets. When disturbed they would take refuge under the water crouching on the bottom. Males were more often found hopping about in daylight in the forest.

Cope recognized specimens from southwestern Costa Rica as belonging to *ranoides.* These originally were described from presumably young specimens, none of which measured more than 26 mm. in length. Cope later reported specimens from Bueno Aires and Terraba, Costa Rica, and lists four color varieties all of which are duplicated in the lots at hand.

This species suggests *Eleutherodactylus nubilus* Günther in many of its characteristics, expecially in the general character of the dorsal and ventral markings on some specimens. The chief reasons for not considering the species identical with *nubilus* is that Günther specifically places the species in the genus *Hylodes,* and those forms

having webbed feet are placed in *Liohyla.* Other characters by which the species presumably differ is that *nubilus* has no outer metatarsal tubercle, the tympanum is smaller, the markings on front side of arm, and front and underside of tarsus differ, and the W-shaped mark on occiput is absent. All these point to a different form.

(In the figure given here the toes are not spread to show the web remnants.)

I have also considered the possibility that *E. ranoides* is a synonym of *Hylodes fitzingeri,* a species so poorly characterized as to make it impossible to determine whether such is the case without direct comparison with the type. The specimens however are, I believe unquestionably, the form referred to by Cope in his (Cope, 1893) paper—specimens from Terraba and Buenos Aires. I find that certain specimens of this form are labeled "*fitzingeri*" in the Harvard Collection.

Eleutherodactylus fitzingeri (O. Schmidt)

Hylodes fitzingeri O. Schmidt, Denksch. k. Akad. Wiss. Wien, Math.-naturw. Cl., vol. 14, 1857, p. 248, pl. 1, fig. 10, (foot only) (type locality, Cordillera of New Granada, 4000 ft.).

Eleutherodactylus fitzingeri Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, p. 386; *ibid.,* Oct. 10, 1931, pp. 410-411 (Barro Colorado I.); *ibid.,* vol. 8, June 7, 1933, p. 64; K. Schmidt, Smithsonian Misc. Coll.; vol. 89, 1933, p. 5 (Panamá).

It would appear that this species was not considered by Cope, Boulenger, Günther or Nieden, although the latter lists it with a question mark, without giving a description. Dunn believes that he has recognized the species as a common frog of Panamá and Costa Rica.

Diagnosis: A considerable remnant of a web on foot, extending distal to base of the metatarsals; back generally smooth; sides granulated; venter smooth; snout to vent length, 30 mm.

Description of the species: (Free translation of type description.) This new species of *Hylodes* which we take the liberty of dedicating to the author of the genus has a very slim body and belongs in the group in which the vomerine teeth do not stand in a zigzag line. In this they are closest to *Hylodes martinicensis* Tschudi; the latter however differs from this, especially by its stout body and from the habitus of most "Hylaformia." We need not go into a very careful description of details but we only emphasize the characteristic criteria.

The toes are correctly regarded as "split" but to avoid any misunderstanding we must mention that on the hind leg between the

third and fourth, and the fourth and the fifth toes there is, unimportant though it may be, the rudiment of a web, since the web reaches and is fastened beyond the ends of the metacarpal bones on the basal phalanges. It seems furthermore that in none of the other species is the os cuneiform primus so well developed as in this case. The dorsum is smooth, however, there are a few small elevations. The venter is also smooth; but on flanks it is granulated; on the thighs only the regions below and lateral to vent are granulated.

Color: The basic color of the dorsum is a grayish brown on which there are black flecks and streaks, the latter chiefly on the limbs. A yellowish streak runs around the curve of the tip of the snout and also goes onto the lower jaw, which on its front side is not rounded off but is truncate. The venter is yellowish but there are smaller dark flecks and the legs are of a uniform dark color from the heel onward.

Measurements in mm.: Body, 30; arm, 18; leg, 54.

The type locality is Cordilleras of New Granada, close to 4000 ft. elevation.

I have considered the possibility that this poorly defined species is the same as the one described herein as *Eleutherodactylus ranoides* Cope.

The form *fitzingeri* has very few characters recorded. Those listed for the foot might apply to one of several species; the body is very slim. The "os cuneiform primus" is especially well developed; skin is smooth, with a few small elevations on dorsum; a yellowish streak runs around the curve of the tip of the snout onto jaw; venter yellowish; above grayish brown on which there are black flecks and streaks. The figure shows the foot possibly one-fifth to one-fourth webbed. I doubt that these characters can prove the synonymy of *fitzingeri* and *ranoides*.

Eleutherodactylus crassidigitus sp. nov.

Figure 31

Type: K.U.M.N.H. No. 28369. Collected, Isla Bonita, eastern slope Volcán Poás between July 22-Aug. 3, 1947 by Richard C. Taylor and Edward H. Taylor.

Paratypes: K.U.M.N.H. Nos. 28360, 28361, 28440, Turrialba and surroundings; 28362-28374, Isla Bonita; R.C.T. Nos. 788a-c, 814, 1675, 2412, 2415, 2784, 2787-2789, 2792, 2796, 2800, 2802, 2803, Isla Bonita; 981-981a, Boquete Camp, west slope of Cerro de la Muerte, elev. 2000 m.

Diagnosis: A medium-sized species (females 44 mm.; males 30.5 mm.) characterized by toes one third to one half or more webbed; finger discs rather small, those on outer fingers much the larger; first finger shorter than second (in male very greatly thickened at base, its diameter more than half length of digit); tympanum of female about one half of eye length, of males equal to or at least about five sixths of eye length; heel reaches much beyond tip of snout; males with large vocal sac and slits; usually two pairs of dark tubercles on back between arms; skin nearly smooth above, with a supratympanic fold present.

FIG. 31. *Eleutherodactylus crassidigitus* sp. nov. Type. K.U.M.N.H. No. 28369. Isla Bonita, Volcán Poás, Costa Rica. Actual snout-to-vent length, 44 mm.

Description of the type: Head oval, not or scarcely as wide as body (exceptionally, wider in certain males and young females) its length (18 mm.) equals its width (18 mm.); snout rather narrow the canthus rostralis sharply distinct; areas about nostrils slightly swollen, the area between forming a flat depression; in lateral profile snout rounded, extending in front of edge of lip nearly two millimeters; upper part of lores nearly vertical, lower sloping

obliquely to lip, the region concave, roughened, with low indefinite pustules; length of eye (5.6 mm.) equal to distance between eye and nostril (5.6 mm.); length of snout, 8.5 mm.; distance between nostrils (4.3 mm.) equal to interorbital width (4.35 mm.); width of eyelid (measured flat) a little greater than interorbital width; tympanum distinct, slightly higher than long (3.4 x 3.1 mm.), its greatest diameter equal approximately to .6 length of eye (in males the proportion is .8 or more); a strong supratympanic fold curving down to near arm insertion, obscuring upper edge of tympanum; two tubercles on eyelid; two conical tubercles between tympanum and arm insertion; in interorbital region an elongate depressed area indicated, extending on to occiput; choanae large, lateral, the interior border somewhat elevated, distance between them 4.8 mm.; vomerine teeth in two almost contiguous, somewhat triangular fasciculi, the anterior points reaching to level of middle of choanae, their posterior level much behind choanae but not quite reaching level of transverse palatal ridges; combined length of vomerine series 4 mm.; tongue large, somewhat oval, a little wider behind (usually) and not or but slightly emarginate behind. (Males with elongate vocal slits, but little external evidence of a vocal sac in male paratypes.)

Arms rather short, wrist reaches tip of snout; heel reaches 10 millimeters beyond tip of snout; fingers with well-developed truncate discs, those of the two inner fingers distinctly smaller than the two outer; first finger equal or minutely longer than second; no finger webs but slight lateral ridges on sides of fingers; subarticular tubercles distinct, rounded, elevated; supernumerary tubercles only moderately distinct; a strong elongate metacarpal tubercle at base of first finger; palmar tubercle large, partly bifid, the outer part the smaller; no distinct row of tubercles under arm.

Legs long, a distinct, elongate, sharp-edged tarsal fold; none or but slightest trace of an outer fold or row of tubercles; toes with well-developed discs, slightly truncate, those on three middle toes largest, nearly size of largest discs on fingers; disc on outer toe not smaller than that of first toe; first three toes half webbed (two-thirds webbed between the second and third toes); about one-third webbed between two outer toes; subarticular tubercles distinct, elevated; no tubercles on sole; inner metatarsal tubercle elongate nearly half length of first toe; outer tubercle small but distinct; heels overlap 8 mm. when legs are folded; a very small heel tubercle.

Skin minutely shagreened above, with some slight tubercles behind orbits and tympanum suggesting remnants of folds; a pair of tubercles a little behind occiput, usually dark, and behind these a

second dark pair more widely separated; a third pair still more widely separated about middle of back, usually not dark colored (black in specimens from Turrialba); one or more tubercles (black or not) behind tympanum; side of body more or less regularly granular or areolate, the granules occasionally encroaching on edges of the well-defined abdominal disc; chin, breast, venter, front face of thighs, small area in groin, outer posterior face of femur and under tibia shining smooth; ventral surface of femur and region about vent granular.

Color in life: Above generally lavender to reddish olive brown, below whitish flesh with some scattered pigment on chin; under surface of sole and part of palm purplish; an indefinite, darker, interorbital bar, behind which, color more intense to near back of occiput; darker dusky marks on arms and legs; between the primary bars very narrow intercalated lines; dorsum and sides slightly clouded; side of lip with at least three indefinite darker marks and a slightly darker area below canthus; a dusky line follows supratympanic fold; tympanum with a dark mark; larger tubercle on sides of shoulders blackish.

Measurements in mm. of Eleutherodactylus crassidigitus sp. nov.

Museum number	K.U.M.N.H. 28369 ♀	K.U.M.N.H. 28362 ♀	K.U.M.N.H. 28371 ♂	K.U.M.N.H. 28368 ♂
Snout to vent	44	44	28.5	28
Width of head	18	17.3	11.5	11.5
Length of head	18	18	11.5	11.4
Length of snout	8.6	8.3	6	5.3
Eye length	5.6	5.8	3.5	3.7
Height of tympanum	3.4	3.5	2.8	2.7
Length of tympanum	3.1	3	2.9	2.8
Arm	25.5	25.2	16.5	16
Hand	13	14	8	7.8
Leg	86	85.4	55	54
Tibia	30	30	19.5	19
Foot and tarsus	39	40	24	24

Variation: The variation in this species is chiefly sexual. The snout-to-vent measurements of eight of the largest females is between 42-44 millimeters; of the eight largest males between 28-30.5 millimeters.

The general color is a light brown to brownish lavender or grayish olive, sometimes nearly unicolor above with or without very indefinite darker clouding. A darker interorbital bar may or may not be distinct, the area on the snout being lighter brown or sometimes having the anterior part lavender. There may or may not be a

W-shaped pattern on shoulder region faintly outlined, with the anterior part of black tubercles marking the lower angles of the "W." Sometimes the area behind the interorbital bar as far back as the "W," is slightly darker than the remainder of the back. The upper edge of the loreal region is usually darker than the remainder and lip spots below eye may be dimly present or almost entirely obsolete. A dark line following the supratympanic fold is present and occasionally widens at the tympanum leaving its upper part dark. Ventral surfaces are white, the chin alone having a very scant peppering of pigment (visible under lens).

R.C.T. No. 2787, has a whitish mark across the front of the orbits, and on each side of head behind the eyes there is a large symmetrical lighter area involving part of the orbits and narrowly separated mesially. This pattern is less distinct in R.C.T. Nos. 2792 and 2794.

R.C.T. No. 2799 is grayish above, the bars on the arms and legs being strongly marked. A white bar crosses the front of the orbits and there is some dark flecking on the sides. The black line along the supratympanic fold is much widened behind tympanum.

Remarks: All the specimens were found moving about on the forest floor, at night for the most part. R. C. Taylor collected a specimen with 26 eggs from under a rock at Boquete Camp on the western slope of Cerro de la Muerte, at an elevation of about 6000 ft.

Eleutherodactylus palmatus (Boulenger)

Figure 32

Leiyla guentherii Keferstein, Nachr. k. Ges. Wiss. Georg-Augusts Univ. Göttingen, 1868, p. 330; Arch. Naturg. Jahrg. 34, vol. 1, 1868, p. 296, plate 9, figs. 4, 5 (*nec Hylodes güntherii* Steindachner, 1864).

Lithodytes guentherii Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 16 (*part.*).

Hylodes palmatus Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum (Natural History), 2nd ed., 1882, pp. 201-202 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 433-434, fig. 317.

Liohyla guentheri Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Apr. 1900, pp. 220, 221, pl. 46, figs. A, A′ ("Costa Rica," "Río Ceibo," "Buenos Aires").

Eleutherodactylus palmatus Barbour, Occ. Papers Mus. Zool. Univ. Michigan, No. 129, Jan. 25, 1923, p. 10.

The species *Hylodes güntherii*, described by Steindachner, I believe must leave *Leiyla guentherii* Keferstein preoccupied if one accepts the synonymy of the genera *Hylodes* and *Leiyla* as I have done in this paper. The next available name is that of Boulenger, *Hylodes palmatus*. It would appear that the name is a substitute name for *Leiyla guentherii* Keferstein to which he refers Cope's

Liyla rugulosa Cope and *Hylodes rugosus* Brocchi. One suspects that his description may be of *rugulosa.*

Günther acquired Costa Rican specimens which he believed were the same as Keferstein's form from Panamá, and retains Keferstein's name since he maintains the species in *Liohyla,* a genus different from *Hylodes.*

The single specimen of this species which I find in my collection was captured at Isla Bonita, in an arboreal bromelia, about 15 feet above the ground and I feel quite certain that it is the identical

FIG. 32. *Eleutherodactylus palmatus* (Boulenger). K.U.M.N.H. No. 28255; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 72 mm.

species figured by Günther (1900, pl. 46, figs. A, A'). Whether this is identical with Keferstein's specimen may be doubted. Should they prove to be different, the name *palmatus* would then not be applicable to this species and it would be without a name.

Diagnosis: Large species (79 mm. ♀); characterized by having toes one-fourth to one-third webbed; digits long somewhat flattened with truncate terminal discs; nearly uniform black or brownish above; below dirty whitish with a broken reticulum of dusky lines; lower lip blackish, spotted regularly with cream; a median cream line on throat bordered with black; posterior part of thighs black

with discrete white or cream spots; groin area marbled dusky and yellow-cream or white.

Description of species: (From K.U.M.N.H. No. 28255.) Head about as broad as long, the canthus distinct, rounded, but becoming angulate near the eye; snout generally oval, rather pointed; loreal region distinctly concave, sloping obliquely to upper edge of maxillary then rounding under to lip edge; nostril swollen slightly; eye large, its length slightly less than the distance between eye and nostril; nostril much nearer tip of snout than eye; tip of snout projecting 2.2 mm.; tympanum oval, diagonally placed, its greatest diagonal diameter (4.1 mm.) more than half length of eye (7.4 mm.); upper eyelid (6.6 mm.) little greater than interorbital width (6.5 mm.).

Choanae moderately large, distinctly larger than the openings of the Eustachian tubes; vomerine teeth in two large triangular elevated fasciculi, separated from each other by a distance equal to their distance from choanae; on each fasciculus teeth numerous (10-11) extending out considerably beyond the inner level of the choanae, the elevated area reaching farther forward than their posterior level; tongue cordiform, large, free for only about one fifth its length.

Arms long, the wrist extends beyond snout two thirds length of forearm; fingers rather long with well-developed discs, somewhat truncate anteriorly, those on outer fingers larger than tympanum; first finger of about same length as second; fourth finger much larger than second; a *trace of a web* between the *three inner fingers* with a ridge continuing along sides of digits to tips; subarticular tubercles low, distinct; only a suggestion of supernumerary tubercles; an elongate much elevated metacarpal tubercle at outer ventral edge of first finger, its length half as long as digit from tubercle to tip; a large palmar tubercle almost divided mesially; tips of discs tend to turn up.

Leg elongate, the heel reaching 10 mm. beyond tip of snout; heels overlap 8 mm. when limbs are folded at right angles to body; toes with truncate discs, the largest distinctly ($\frac{1}{4}$) smaller than two largest finger discs; disc on fifth toe smallest; fifth toe fails to reach as far forward as third; three inner toes, approximately one third webbed; less between third and fourth, and with only a vestige between fourth and fifth; a lateral fringe or ridge to discs on all digits; a large inner metatarsal tubercle, with an outer not (or only faintly) indicated; subarticular tubercles large, flattened; no supernumerary

tubercles on the sole; moderately distinct, narrow elongate tarsal fold two thirds of the length of the tarsus.

Skin on dorsal surface of body and limbs lacking all folds and warts save a small round tubercle near tympanum and a narrow curving supratympanic fold, very clearly defined, terminating above and behind jaw angle; under a lens the skin is seen to be finely and smoothly corrugated; a very fine irregular fold traceable from occiput along each side of body (appearing like a vein); some granules about jaw angle, on sides (anteriorly), on mesial part of under face of thighs, and below anal region on posterior face; remainder of under surfaces, chin, throat, venter, as well as limbs, very smooth, with none or only a faint suggestion of a discoidal ventral disc.

Color and markings: Dark olive brown on back without spots; a vaguely defined, median, hair-fine line of light brown; arm and legs uniformly olive brown above; side of head rather dark, with at least four very indistinct darker marks, becoming better defined on the edge of the lip where they are separated by discrete cream spots; two tiny white spots just below lower rim of eye; tympanum black followed by a discrete diagonal black spot; sides of body lighter olive-brown, with whitish flecks, or posteriorly, larger discrete yellow spots; front of thigh clouded lighter and darker with a few yellow spots near groin; back of thigh black with numerous small yellow-cream spots; under surface of tibia clouded with dirty white and yellowish spots; palm and sole with digits deep purplish; chin with a black rim showing well-defined cream spots paired with similar spots on upper jaw; chin dusky, clouded with a dark-bordered, median whitish stripe; venter whitish, reticulated with dusky brown; under side of thighs with finer reticulations.

Measurements in mm. of Eleutherodactylus palmatus

Snout to vent	72	Eyelid width	6.6
Width of head	26.3	Interorbital width	6.5
Length of head	26	Arm	51
Length of snout	11	Hand	26
Height of snout	8.1	Leg	135
Length of eye	7.4	Femur and tibia	80
Tympanum	4.1 x 3	Tibia	43
Eye to nostril	7.8	Foot and tarsus	63

Remarks: I cannot but have some doubt that the *Leiyla guentherii* described and figured by Keferstein [*] is the same as this species. The figure shows a round tympanum, digital discs much smaller

[*] Arch. für Naturg. Jahrg. 34, vol. 1, 1868, pp. 296-297, pl. 9, figs. 4, 5. (type locality Costa Rica).

than the tympanum and numerous warts and tubercles are present. The first finger is longer than second; the tympanum does not have small white flecks on a black surface, and there is no trace of a finger web. The color and markings are different.

As I have stated, my specimen, in general appearance, resembles the specimen figured by Günther as *Liohyla güntherii*,† especially in the coloration of the ventral surfaces.

There is no distinct lighter area on the snout, and the dorsum is somewhat darker. Günther seemingly was not wholly certain of the identity of his specimen and suggests its relationship with *Hylodes raniformis*.‡ The type description of *raniformis* deals with a related frog, 70 mm. long. However, it differs from the species at hand in that the vomerine teeth are in two short series; first finger distinctly longer than second; subarticular tubercles very strong; toes one-third webbed; an indistinct outer metatarsal tubercle; ill-defined darker spots above on body; a blackish streak below canthus; limbs dark spotted; hinder side of thighs whitish, reticulated with dark brown; lower parts white, throat sometimes speckled; male with a vocal sac. Boulenger states that it is distinguished from *palmatus* by a broader interorbital region, smooth skin, and larger size. The type locality is "Buenaventura and Cali," Colombia.

Eleutherodactylus pittieri (Günther)

Liohyla pittieri Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1900, pp. 223-224, pl. 65, fig. B, B′ (type locality, "Costa Rica"; and Boruca, Costa Rica. Here restricted to the latter locality. Pittier de Fahega coll.).

Hylodes pittieri Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 435 (Costa Rica).

Eleutherodactylus pittieri Dunn, (*part.*) Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 108-109 (regarded as conspecific with *punctariolus*).

Diagnosis: This large arboreal frog (♀ 60 mm.; ♂ 51) may be identified by the following characteristics: male without vocal sac, or vocal slits; first finger longer than second; toes scarcely one fourth webbed; one metatarsal tubercle; length of body less than distance between heel and vent; tympanum nearly round; in male ¾, in female ½ eye; thighs black behind with small punctate yellow spots; no red on ventral surface. Heel reaches to beyond snout-tip.

Description of species: (From Günther *loc. cit.*) "Closely allied and very similar to *L. fleischmanni*. Habit rather robust, the length of the body being a little less than the distance between vent and heel. Snout not projecting beyond the mouth, of moderate length,

† Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1900, pl. 66, figs. A, A′.

‡ Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 17, 1896, p. 19.

with obtuse canthus rostralis and sloping sides. Tympanum round, three-fourths the size of the eye in the male, and about one-half in the female. Vomerine teeth as in *L. fleischmanni*. Male with some short tubercular folds and small tubercles on the side of the back, female nearly smooth. Abdomen smooth, without folds. Disks on the fingers small, of the toes moderately developed. *First finger longer than the second.* Toes barely one-fourth webbed. One metatarsal tubercle; a tarsal fold. *The hinder side of the thighs black, with well-defined small round lemon-yellow spots;* throat brownish, minutely speckled with yellow; abdomen whitish. Male brownish, faintly marbled with darker colour, sides marbled with yellowish; a narrow yellow vertebral line and a light interorbital cross-band. Female nearly uniform brownish-black above; sides marbled with yellowish."

Measurements in mm. female and male respectively: "Length of the body, 60, 51; distance between vent and heel, 62, 52; length of hind limb (from vent), 104, 87."

Remarks: "I have long hesitated before I ventured to distinguish this frog under a distinct name; however, the receipt of a second specimen agreeing in every essential distinctive character with the first, removed every doubt about the species being distinct from *L. fleischmanni*. The male has the testicles well developed, yet lacks vocal sacs. These organs are present in much smaller specimens of *L. fleischmanni.*" This species described and excellently figured by Günther *loc. cit.* was found to be common in the region about Moravia. The species is decidedly different from *Eleutherodactylus fleischmanni* that occurs in the same general region. *E. pittieri* males lack the vocal sac and slits, and also lack the nuptial asperities on the first finger, which is longer than the second.

In a series of some 20 specimens taken at Moravia the five largest females measure, 60, 62, 62.5, 69, 72 mm.; the five largest males, 38, 38, 39, 39, 45 mm. All were taken along small rivulets at night. During the day they were effectively concealed.

The skin is usually rough with tubercles, short ridges and a more or less general corrugation. Some specimens have the dorsum rather smooth. The digital discs are relatively small, those on hand smaller than those on toes. In the large female the area of the largest toe disc is about one third of the area of the tympanum. The snout projects very slightly beyond mouth. The abdomen is smooth with a ventral disc usually outlined in the adults. The first finger is longer than second. The male has no nuptial asperities on the dorsal and dorsolateral surface of the first finger. In these speci-

mens the outer metatarsal tubercle is present but it is very indistinct and might be overlooked (absent in the types). The toes are about one-fourth webbed. The vomerine teeth are far behind choanae in two triangular fasciculi, the teeth in transverse series are separated by one fifth the width of a fasciculus. The tongue is rather small, subcircular, one fifth or less free behind and very slightly nicked. A strong inner tarsal ridge is present two thirds of the length of tarsus, arising from the edge of the inner tubercle. The sole and palm lack supernumerary tubercles, the subarticular tubercles being somewhat elongate. The general color is black or blackish above with a darker interorbital bar and some indefinite dorsal marks can be discerned when the specimen is submerged.

The sides are variegated, black with some white areas in groin, or light with black areas. The back of the thighs have small yellow or silvery-white flecks. There are only very indistinct marks on the lips; the legs are barred with darker.

The type locality Boruca is "situated in a small bowl-shaped valley in the hills on the north side of the Rio Grande de Terraba; having an altitude of 1500 feet," on the Pacific side of Costa Rica rather close to the Panamá border.

The greater smoothness of the types and the absence of the outer metatarsal tubercle may be individual variation, for at best the outer tubercle is small, often nearly obsolete.

Eleutherodactylus fleischmanni (Boettger)

Hylodes fleischmanni Boettger, Katalog der Batrachier-Sammlung im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, Aug. 1892, p. 27-28 (type locality, San José, Costa Rica; Carl Fleischmann, coll.); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1900, p. 222, pl. 64, fig. B; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 434-435.

Eleutherodactylus fleischmanni Barbour and Dunn, Proc. Biol. Soc. Washington, vol. 34, Dec. 21, 1921, p. 161 (Santa Cecilia, Guápiles, La Palma and Cariblanco) (spelled *fleishmanni*); Dunn, Acad. Nat. Sci. Philadelphia, vol. 92, 1940, pp. 108-109.

Diagnosis: Toes slightly webbed at base with small narrow lateral fringes; belly smooth; head broader than body; tympanum large round; interorbital region flat; leg brought forward the heel joint reaching beyond tip of snout; no lateral glandular fold; no well-defined ventral disc. Male with vocal sac.

Description of species: (Free translation of type description.) Tongue oval unemarginate; vomerine teeth in two strong fasciculi behind level of choanae; head rather broad, distinctly broader than body; snout somewhat pointed, convex or curved on under side of tip; longer than diameter of eye; canthus more distinctly curved

and angular anteriorly than posteriorly; nostril twice as far from eye as from tip of snout; interorbital space as broad as a single eyelid; tympanum round, almost as large as eye; ostia pharyngea almost as large as choanae; fingers of medium length, first somewhat longer than the second; toes rather long, clearly connected at base, and with narrow lateral skin fringes; discs on fingers and toes small; subarticular tubercles moderately developed; two metatarsal tubercles, the outer round but less distinct than inner; the hind leg brought forward, the last fourth of the tibia reaches beyond tip of snout; skin smooth on dorsum with narrow warty ridges or tubercles; irregular glandular folds on eyelids and sides of body; one or two whitish tubercles on posterior lower edge of tympanum especially distinct and significant; venter smooth.

Color: Ash gray dorsally with a black powdering of pigment and with now and then a black dot; sides of head and body light gray with black flecks and marbling; a fine white dorsal streak as well as a carmine red band between the eyes; and similar red flecks on center of back and thighs may or may not be present; the dark bands on limbs wanting, or very obscure, but back of thighs black with white flecks; underside dirty white; borders of lower jaw grayish with white flecks and sometimes a narrow longitudinal line on middle of throat, which is also white; posterior part of belly and ventral side of limbs yellowish; iris brass-colored.

Measurements in mm. of cotypes: Head-body length, 35, 34; width of head, 14½, 14; diameter of eye, 4, 4; diameter of tympanum, 3½, 3½; length of arm, 21, 21; length of leg, 64, 64½; length of thigh, 21, 21; length of tibia, 21½, 21½; diameter of disc (4th toe), 1½, 1¼.

Remarks: Boettger regards the species as being related to *Eleutherodactylus palmatus* Boulenger but differing in having the webs less developed, unemarginate tongue and in having an outer metatarsal tubercle.

He does not state that this species has vocal sacs, in fact he does not mention the sex; however, from the size of the tympanum (almost as large as eye) one is assured that at least one of the types is a male. Since the character is not mentioned as present or absent, one suspects that the types were not examined for this character. However, Günther (*loc. cit.*) states that vocal sacs are present in this species even in young males.

A series of specimens acquired on the northeastern slopes of the Cordillera Talamanca are referred to this species. They come from an elevation of approximately 6000-6500 ft. elevation. Most of the specimens were collected from under stones in open pasture areas

or along the roadside. The two largest males measure 47 and 48 mm., the females 61 and 75 mm. The following is a detailed description of the largest female specimen in the above series, K.U.M.N.H. No. 4986.

Description of species: Head broader than body, its length (26 mm.) less than width (29 mm.); snout rather short, truncate oval, the canthus rounded, the lores sloping obliquely to lip, the loreal region only slightly concave; length of eye (9 mm.) greater than the distance from eye to nostril (7.7 mm.), a little less than length of snout (9.4 mm.); tympanum higher than wide (4.4 x 3.5 mm.), separated from eye by 4.5 mm.; width of an eyelid equal to, or slightly greater than interorbital space; depth of head at tympanum 12 mm.

Vomerine teeth in two triangular fasciculi, their apices arising anterior to the posterior level of choanae, separated from each other by a distance equal to a sixth of transverse width of a fasciculus and from choanae by a third of this width; tongue rather large, broadly cordiform, slightly notched behind; less than a sixth free behind (males with elongate vocal slits but no external evidence of a vocal sac); choanae somewhat lateral, much smaller than the distinctly triangular ostia pharyngea; anterior border of choanae flare out somewhat.

Arm moderately long, the wrist reaching one third of the length of forearm beyond snout; inner fingers equal; the pads or discs well developed, but less than half area of tympanum in female (less than a third in male); the second and third fingers have a fringe or ridge on their inner border, representing a web remnant; subarticular tubercles somewhat elongated; a trace of supernumerary tubercles on hand; a prominent inner metacarpal tubercle; outer (palmar) tubercle large, low, partly bifid; male with prominent areas of nuptial tubercles on first finger and on metacarpal tubercle. Leg long, the heel reaching more than ten millimeters beyond tip of snout; when legs are folded the heels overlap two mm.; toes distinctly less than one-fourth webbed; the fringes extending on all toes to discs, the discs distinctly larger than those on fingers; a compressed, elevated, inner metatarsal tubercle; a small nearly obsolete outer metatarsal tubercle; subarticular tubercles elongated; a faint trace of an abdominal disc; a tarsal fold or ridge extending nearly half length of tarsus.

Skin above roughened, with pustules more distinct anteriorly, sides finely granular; chin, belly, and under side of limbs smooth, save below vent and on posterior face of thighs near vent; a strong, overhanging tympanic fold curving down (or angulate)

behind tympanum; a pair of tubercles between the tympanum and leg insertion.

Color nearly black with some variation in intensity visible when the specimen is submerged; sides lighter with some black spots; ventral surface dirty white, more pigment scattered on chin and throat than under arms, thighs, and abdomen; palms, soles and under tarsi black.

Some discrepancies between this description and the type description exist, but if Günther (*loc. cit.*) has identified the form properly, it is the only Costa Rican species of these very large frogs in which vocal slits are known to be present in the male; Günther figures a specimen that has a smoother dorsal surface than the one described. Some of the other specimens in the series show a much smoother condition of the dorsal skin.

Eleutherodactylus engytympanum (Günther)

Liohyla engytympanum Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1900, p. 224 (type locality, Monte Redondo, Costa Rica; C. E. Underwood coll.).

Diagnosis: A large frog (59 mm.); canthus distinct; tympanum an irregular oval higher than long, barely half area of orbit in female; choanae wider than ostia pharyngea; hind limb with tubercles and granules; digital discs equal, rounded, moderately developed; first finger longer than second; a rudimentary web between three inner fingers; toes one-fourth webbed; yellow vertebral line; yellow gular line.

Description of species: "In general habit and form of the head similar to *L. rugulosa*. Snout rather obtuse, with the canthus rostralis distinct, and with sloping sides; eye scarcely equal to its distance from the nostril. *Tympanum an irregular oval, deeper than long, barely half the area of the orbit* (in adult female). Vomerine teeth in two short prominent transverse series, slightly separated from each other, behind but within the level of the choanae; choanae rather wider than the Eustachian openings. Upper and lateral parts of the body, supra-orbital region, and upper parts of the hind limbs with tubercles and granules; a glandular fold above the tympanum; abdomen smooth, with indistinct granules on the sides; transverse and longitudinal folds indicate the presence of an abdominal disk. Length of the body a little less than the distance between vent and heel. Disks of fingers and toes subequal, rounded, moderately developed; first finger rather longer than the second; a rudimentary web between the three inner fingers. Metatarsals without pads, except at the base of the inner toe; outer metatarsal tubercle scarcely

visible; a tarsal fold. Toes one-fourth webbed. Greyish, with a yellow vertebral and gular line; an indistinct dark interorbital cross-band. Upper lip and flanks with blackish spots. Upper parts of the limbs obscurely banded; hind part of the femur rather finely and conspicuously marbled with black and white. Lower parts white. (One adult female.)

Measurements in mm. of one adult female: "Length of the body 59; distance between vent and heel, 62; length of foot, 47."

Eleutherodactylus talamancae Dunn

Figure 33

Eleutherodactylus talamancae Dunn, Occ. Papers, Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 385-386 (type locality, Almirante, Bocas del Toro, Panamá, Dunn and Duryea colls. Also reported from Monteverde, Zent and Suretka in Costa Rica); Proc. Acad. Nat. Sci. Philadelphia, vol. 92, 1940, p. 108. (From Chiriquí Lagoon in western Panamá north to Bluefields, Nicaragua; lower Reventazón, Costa Rica); Gaige, Hartweg, Stuart, Occ. Papers Mus. Zool. Univ. Michigan, No. 357, 1937, p. 6 (Río Mico, Nicarargua).

Diagnosis: Elongate head; fine granular corrugation on the dorsal surface of body and limbs; small vestige of web on foot; large finger discs on the *two* outer fingers, discs small on two inner fingers; vocal

FIG. 33. *Eleutherodactylus talamancae* Dunn. K.U.M.N.H. No. 28355, Turrialba, Costa Rica. Actual snout-to-vent length, 29.5 mm.

sacs present in males; heel reaching beyond the snout; females reach a size of 47 mm., males, 29.5.

Description of species: (K.U.M.N.H. No. 28355 Turrialba, Costa Rica.) Head narrow, oval, its length (13 mm.) greater than its width (11 mm.); in male, head wider than body, in female about same width; snout broad, the distance between nostrils (3.2 mm.) equals interorbital distance; lores somewhat concave, areas about nostrils swollen, with a slight depression between and on tip of snout; tip of snout extending about 1 millimeter beyond edge of lip; eye length (4 mm.) minutely greater than distance between eye and nostril (3.9 mm.); snout length, 5.3 mm.; tympanum (♂) large, a little longer than thigh (2.8 mm. x 2.3 mm.), its length .7 of eye length; a strong supratympanic fold curves down from eye to above arm insertion; an elongate tubercle behind jaw angle extending on lower jaw; width of an upper eyelid slightly less than interorbital width; vomerine teeth in two elevated somewhat triangular fasciculi between inner level of choanae but extending considerably behind posterior level, but not out to inner level, separated by less than half the length of one fasciculus; tongue subcircular a little longer than wide, not emarginate behind, free for only one fourth or less of its length. (In a paratype specimen E.H.T.-H.M.S. No. 29873 the fasciculi are a little larger and the tongue has a small posterior notch.) Choanae rather large, largely lateral in position; vocal sac present, not evident externally; a pair of elongate vocal slits.

Arms short, the wrist reaching tip of snout; first finger as long as second, thickened at base (♂) with a nuptial pad above the joint; subarticular tubercles present, large; supernumerary tubercles present but very indistinct; a large inner metacarpal tubercle at base of first finger; a relatively small outer palmar tubercle, bifid or tripartite; discs on two inner fingers small, distinct; those on two outer fingers large, half length of tympanum.

Legs long, the heel reaching four millimeters beyond tip of snout; no inner or outer tarsal tubercles or folds; subarticular tubercles distinct; no trace of supernumerary tubercles; a moderately large inner metatarsal tubercle, a small distinct outer; a trace of a web between inner toes, practically wanting between two outer toes; discs on middle toes equally as large as those on outer fingers, those of inner and outer toes smaller than other three.

Skin above finely corrugated, relatively smooth on top of head; rump slightly rougher; some of the slightly larger tubercles may tend to form rows; a very indistinct lateral fold; chin, breast and venter smooth; sides distinctly and smoothly granular, the granules

encroaching but little on venter; a trace of a discoidal disc on belly; median part of ventral surface of thighs granular; area below and lateral to vent granular, extending on posterior part of thighs for nearly half their length; a line of granules on the dorsal surface of thigh; front face of thigh entirely smooth.

Color: Dorsal color in preservative dusky brown with a dim dark area between orbits across hand, anterior to which color is lighter brown with some dusky markings; some indistinct darker markings that tend to outline an hourglass-shaped area; posterior to sacrum two or three very indistinct, broken dark transverse lines; legs and arms with dusky cross bars; the posterior face of femur nearly uniform dark brown; underside of tibia with some dark marks; below grayish white, or with a moderate peppering of pigment irregularly distributed; underside of foot and palm purplish; a cream mark above arm and some diagonal lighter marking on sides, distinct near groin; tympanum brown, a dusky area on loreal region and a dark line follows supratympanic fold. In life, yellow-olive above, the occipital region darker; tympanum brown; legs banded gray and olive; chin, throat, and abdomen whitish to cream, posteriorly; a faint pinkish suffusion in groin; magenta on underside of tibia; light marks on sides yellow-cream.

Measurements in mm. of Eleutherodactylus talamancae

Museum number	K.U. 28355 ♂	M.C.Z. Paratype 9972° ♀	M.C.Z. Type 9879 ♀
Snout to vent	29.5	34	46
Width of head	11	11.5	16.14
Length of head	13	14	20
Snout	5.3	6	8.5
Eye length	4	4.1	6
Tympanum length	2.8	2.1	3.2
Tympanum height	2.3	2.1	2.6
Arm	17	20	27.2
Hand	9.5	10	14
Leg	51.5	59	85
Tibia	17.2	20.6	30
Foot and tarsus	25.3	26	37

Remarks: I have examined two males of approximately the same size from the Morehouse Finca, approximately 4-4½ miles south, Turrialba. They were in brush 6 to 8 feet high and were discovered by tracing a loud "squawk" which at first was thought to be that of a *Hyla*. The specimens were not actually seen making the call.

° No. 9972 La Loma, Panamá.

However there appear to be areas of loose skin at the angles of the mouth suggesting paired vocal sacs.

Two paratypes have a considerable lot of pigment on entire ventral surface (the type is said to be white below).

I have seen certain other specimens: M.C.Z. No. 9879, the type, Almirante, Panamá Republic, 47 mm. snout-to-vent length; M.C.Z. No. 7952 Monteverde, Costa Rica 21 mm.; M.C.Z. No. 9786; M.C.Z. Nos. 9795-97, Suretka, Costa Rica.

The following localities are known in Costa Rica: Guápiles, Zent, Monteverde, Suretka and Turrialba.

Eleutherodactylus platyrhynchus (Günther)

Figure 34

Hylodes platyrhynchus Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Aug. 1900, pp. 230-231, pl. 67, fig. a (type locality, Costa Rica); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 436, fig. 318. (Costa Rica).

Diagnosis: Moderately large species, females 57 mm. (the type 56 ♀); males 42 mm.; *venter finely granulate or areolate* over a considerable part of its surface, (a character not exhibited by other large eleutherodactylid species occurring in Costa Rica). Head moderately broad in females, less so in males; tympanum in female little more than one third, in male, one half to three fifths length of eye; nearly smooth above with one or two short skin-folds from orbit; discs on digits large, truncate, those on fingers larger than toes; heel to nostril; olive to brown above, with some black markings; white below. Males with large vocal slits.

Description of species: (K.U.M.N.H. No. 28276 ♀, Isla Bonita Volcán Poás, Costa Rica.) Head as broad as body (usually broader in males), the length (22 mm.) slightly less than width (23 mm.); canthus distinct, slightly angulate near orbit, rounded for most part and curving; area about nostrils swollen, with a slight depression between and from which point snout slopes downward to tip; a a slightly elevated median point immediately in front of depression; snout-tip rather rounded oval, projecting slightly beyond edge of lip (1.5 mm.); eye directed somewhat forwards; length of eye (6.2 mm.) greater than distance between eye and nostril (5.1 mm.); length of snout, 9.2 mm.; width of an eyelid (4 mm.) less than interorbital width (4.8 mm.); distance between nostrils 4 mm.; tympanum relatively small, its height greater than its length (3.2 mm. x 2.3 mm.); a discrete curving supratympanic skinfold obscuring upper posterior edge of tympanum. A glandular tubercle back of jaw angle; another glandular tubercle at end of curved supra-

tympanic fold; loreal region somewhat concave, surface roughened, sloping obliquely to lip posteriorly, anteriorly the jaw forming a distinct ledge (not well indicated in younger specimens); a distinct medial occipital depression formed by the elevated musculature surrounding it, in front of which is an irregular pustule and just at anterior level of eyes a pair of indistinct interorbital pustules;

FIG. 34. *Eleutherodactylus platyrhynchus* (Günther). K.U.M.N.H. No. 28268; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 46 mm.

the raised occipital area outlined laterally by a pair of skinfolds that continue behind occiput; a tubercle on eyelid.

Choanae small, only partly lateral; vomerine teeth in two large triangular fasciculi very narrowly separated, the upper apices of triangles reach posterior level of choanae; but posterior transverse toothed edges much behind their posterior level (as well as the level of the transverse palatine ridges) and extending outward beyond inner levels of choanae; teeth 10-8; length of tooth-row 4 mm.; distance between choanae 3.6 mm.; tongue an elongate oval, little broader behind, not or but very slightly emarginate, free for approximately one fourth of its length.

Arm large, one half of forearm reaches beyond tip of snout, first finger much shorter than second; three outer digits with strong discs, somewhat truncate, showing (or not) slight emargination on their front edges, the discs much larger than tympanum; widest disc 3.2 mm.; subarticular tubercles large, rounded, elevated; supernumerary tubercles scarcely indicated; an elongate outer metacarpal tubercle at base of first finger; palmar tubercle large, rather indistinct, bifid or nearly so; three or four tubercles under arm in row; no web but fingers with slight lateral ridges.

Leg with heel reaching nostril; toes with large truncate discs, smaller on inner and outer toes, none as large as those on fingers; subarticular tubercles all well developed without trace of supernumerary tubercles; a large inner metatarsal tubercle, somewhat flattened, bearing a narrow free edge on outer anterior part; outer tubercle not or but faintly indicated (on most specimens no trace apparent); no tarsal fold or tubercle (certain specimens have a trace only of a tubercular fold). Web indicated, nowhere reaching posterior level of the subarticular tubercles but with a trace following digits on their sides as low ridges; heels overlap 5 mm. when legs are folded.

Skin of back and sides with some very fine granules and a few somewhat larger low pustular elevations; on sides general distribution of tubercular or pustular granules; the upper surface of limbs, front and most of ventral and much of posterior surface of thigh, smooth; chin smooth with some longitudinal wrinkling; outer and posterior surface of venter granular, the remainder of venter and breast wrinkled or smooth. A patch of granules on ventral and posterior part of thighs and to some extent on side of region of vent; some specimens have the upper surface of limbs showing small tubercle (especially males) (some specimens seem to have lateral ventral folds suggesting a discoidal disc); a tubercle on heel.

Color: Olive-brown above with some minute black spots on ridges or tubercles; arms indistinctly marked with dusky; legs strongly barred, three each on femur, tibia and tarsus; a dim dark line along upper edge of lores; a dark line widening to a spot above tympanum; a small oval black spot on tympanum but smaller than latter; three dark lip-spots with somewhat lighter centers; venter dirty grayish white (a fine equal distribution of pigment everywhere on surfaces of venter); posterior part of thigh barred; dorsal part barred but slightly lighter; some indefinite darker marks on upper part of sides.

Measurements in mm. of Eleutherodactylus platyrhynchus (Günther)

Museum number	K.U.M.N.H. 28276 ♀	R.C.T. 2774 ♀	R.C.T. 2763 ♂	B.M. Type
Snout to vent	57	46	42	56
Vent to heel	53	. .	. .	59
Length of head	22	17	16.5	. .
Width of head	23	18	17	. .
Length of snout	9.2	6.5	6.2	. .
Eye length	6.2	5	4.8	. .
Tympanum length	2.3	2	2.8	. .
Tympanum height	3.2	2.6	2.9	. .
Arm	35.3	32.1	27.2	. .
Hand	20.1	15	13	. .
Leg	90	79	69	. .
Tibia	30	27	23.2	. .
Foot and tarsus	44	38	32	. .

Variation: In the material available to me are 25 specimens all taken at Isla Bonita. The following major color varieties appear.

R.C.T. 801 ♀. Side of head and body black; occiput and back deep rich wood-brown, faint indications of darker bars on legs. Magenta flecks on back of thigh and under tibia where the spots are distinct; venter dirty gray-white; feet below purplish; (in preservative less dark and some fine black dots border the dorsolateral region); inner fingers light above. Only one specimen with this pattern.

K.U.M.N.H. No. 28267 ♀. Top of snout brown; a dark interorbital bar; beginning here a broad reddish clay stripe to end of body; fold with black edging; lip spots present and spot on tympanum; regular bars on gray thighs nearly obsolete, more distinct on tibia; below uniform grayish white. (Only one specimen with this pattern).

K.U.M.N.H. 28269 ♂, R.C.T. 2763 ♂, 2774 ♀. Dorsum rather lavender-gray, darker in interorbital region and lighter anteriorly; limbs indistinctly barred; lip spots not strongly indicated; venter gray-white, uniform or clouded under thigh; in one some darker flecks in a line dorsolaterally.

K.U.M.N.H. Nos. 28270 ♂, 28273 ♀, R.C.T. Nos. 2766 ♂, 2772 ♂. Dark lavender-brown above with a hair-fine tan line from snout tip to end of body; a white line across posterior surface of thigh; other typical markings present.

K.U.M.N.H. No. 28354 (35 mm. ♀ yg.). Rather typically colored above save that the black color following the occipital fold is more

intense and is bordered by whitish, which continues indistinctly back as two indefinite lines; spot on sides more intense; legs strongly barred with black; lower part of thigh black; areas without pigment on back and front of thigh between bars are cream yellow; whitish under tibia and foot and part of arm; dim lavender-red to magenta in axilla; snout magenta; pigment on venter segregated in many places in small black flecks or spots especially evident on under surfaces of thigh; under surface of feet, deep purple slate; hands similar, save inner fingers yellowish.

R.C.T. Nos. 803 ♂, 2775 ♀. These are dark blackish brown above with the typical markings on dorsum and sides; below nearly uniform blackish with some ashen flecks.

K.U.M.N.H. No. 28353 ♀. Light brown above with a light interorbital band followed by a darker area; a dim dark line crosses snout; a lighter reddish area above arm insertion; groin and lighter parts of hind legs, under and upper part of feet similar; back of thigh, chin, and venter whitish flesh; a pink spot on palm; bars on limbs very light brown, separated by whitish.

The structural characters of these specimens are not so variable: lack of webbing, size of discs, and length of limbs are generally constant; the vomerine series are smaller in younger specimens. The folds and tubercles differ somewhat from Günther's figure (*loc. cit.* pl. 67, fig. a). There the skin is shown with the folds not approximating each other to the same extent as in the figure given here, and there is less evidence of tubercles on back, and the banding on the thighs is more distinct. However all these characters depicted can be duplicated in other specimens at hand from the same locality.

Many of these specimens were taken in bromelias. Since there are no very young specimens in the collections I suspect that the young are largely or exclusively arboreal in habit. Since the two smallest (and youngest) specimens exhibit the brightest colorations, reds, magentas, and yellows, I suspect that these colors may be prevalent in the very young.

The details of significant structural characters are repeated so faithfully that on the evidence at hand one can scarcely regard these striking color differences as anything other than color variation.

The large female described herein contained an adult salamander *Magnadigita subpalmata* in the stomach.

Eleutherodactylus nubilus (Günther)

Figure 35

Hylodes nubilus Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1901, p. 237, pl. 69, fig. a (type locality, Escazú, Costa Rica; C. E. Underwood, coll.).

Diagnosis: Body rather slender; head flat, moderately wide; lacking web on hand and feet; discs on fingers and toes developed, former larger; abdomen smooth; choana and ostia pharyngea equal in width; skin above smooth or with some short narrow glandular folds; first finger longer than second; a tarsal fold; no subarticular tubercles on metatarsals; dark purplish with some darker clouding forming four indistinct longitudinal bands.

FIG. 35. *Eleutherodactylus nubilus* Günther. Redrawn from Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1901, Plate 69, fig. A. Specimen from Escazú, Costa Rica. Snout-to-vent length, 44 mm. (?).

Description of type: "Habit rather slender, the length of the body equal to the distance between the vent and heel. Head flat, moderately wide; snout rather produced, with distinct canthus rostralis and subvertical sides. Tympanum half the area of the eye (in an adult female). Vomerine teeth in two short transverse series, rather approximate to each other, considerably behind the choanae, but within the level from their inner margins. Choanae and Eustachian tubes equal in width. Skin of the upper parts smooth, only the regions above the shoulder and behind the supraciliary show some small tubercles and short narrow glandular folds; abdomen smooth. Disks of the fingers small, but distinctly developed and larger than those of the toes; first finger longer than second. One metatarsal tubercle, a tarsal fold; metatarsals without subarticular tubercles. Dark purplish, clouded with darker, the darker parts concentrated in four indistinct longitudinal bands, the middle of which reach almost to the snout. Hind limbs and upper lip indistinctly cross-banded; thigh finely marbled behind with brown and whitish. Lower parts whitish, with small blackish-brown marblings, a band along the middle of the throat being pure white."

Measurements in mm.: Head and body, 44 mm.; hind limb, 78 mm.; distance between vent and heel, 43.5 mm.

Remarks: I have seen no specimens of this species.

Eleutherodactylus peraltae Barbour

Eleutherodactylus peraltae Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, pp. 30-31, pl. 4, fig. 1 (type locality, Peralta, Costa Rica, 500 m. elevation).

Diagnosis: "A small species with broad, flat head, very long limbs, small disks and very small groups of vomerine teeth. Tympanum large and very near eye.

Description: "Vomerine teeth in two very small groups within the inner margin of the choanae, the anterior border of each group lying just ahead of a line connecting the two choanae; the groups widely separated, farther from each other than from either choana, separated by a distance equal to the length of one of the groups; snout long and depressed; nostril nearer to tip of snout than to eye, separated from eye by a distance considerably in excess of the latter's diameter; interorbital space slightly wider than the upper eyelid; tympanum ill defined, rather small, between one half and one third the size of eye, separated from the eye by a distance about equal to its own diameter; fingers slender, with medium disks; disk of fourth finger distinctly largest; first toe rather short,

slightly shorter than second, which again is slightly shorter than fourth; toes long, slender, free, first toe with very small disk, second and third with disks distinctly successively larger; subarticular tubercles well developed; sole almost smooth; a larger inner and small outer metatarsal tubercle; the hind limb being laid forward along the body, tibio-tarsal articulation reaches well beyond the tip of snout; heels overlap considerably when the hind limbs are placed vertically to the body axis; skin smooth above; smooth on throat and chest; coursely granulate on abdomen and sides of thighs.

Color: "Above brown, beneath yellow; femores with four, tibiae with four, tarsus with two indistinct dark crossbands.

Measurements in mm.: "Tip of snout to vent, 27; width of head, 10.5; fore limb, 16; hind limb, 47; tibia, 17.5 mm."

Remarks: I have seen no specimen that I am able to refer to this form with assurance.

Eleutherodactylus euryglossus (Cope)

Lithodytes euryglossus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 196-197 (type locality, San José, Costa Rica. Sen. P. Biolley coll.).

Diagnosis: A large species (75 mm.); heel reaches between eye and nostril; tympanum a vertical oval its height ⅔ eye (♀?); tongue openly notched; vomerine teeth in line with back level of choanae; ostia pharyngea larger than choanae; discs distinct, small; digits lacking dermal margins; first and second fingers equal.

Description of species: "A large species with small pallets, in which the heel does not reach the end of the muzzle, although it extends to a point anterior to the eye. General appearance that of a *Leptodactylus.* No distinct canthus rostralis; end of muzzle sloping backwards from lip-border. Tympanic disc a vertical oval, of which the long diameter is two-thirds that of the eye. Nostril nearer the end of the muzzle than its distance from the orbit. Tongue wider than long, openly notched posteriorly. Choanae moderate. Vomerine teeth in two transverse series, on transverse ridges whose anterior borders are in line with the posterior borders of the choanae, and whose external borders are a little within the internal borders of the choanae. Ostia pharyngea larger than choanae. Pallets distinct but shall, smallest on the manus. Digits without dermal margins. First and second fingers equal. Integument everywhere smooth. A discoidal abdominal fold. A fold on the distal half of the external border of the tarsus, extending to a rather prominent praehallucal tubercle.

"Color above, brownish lead-color; below whitish. Groin reticulate, and sides punctate with the dorsal on the ventral color. Four brown spots on the upper lip anterior to the line of the tympanum,

and a black streak above and behind the tympanum. A blackish cross-band between the posterior parts of the orbits, and some black longitudinal spots on the dorso-lateral region, bounding upwards the paler color of the sides. Limbs with obscure blackish cross-bands. Thighs behind, whitish at base, and obscurely reticulate on the superior and distal portions. Limbs below, and gular region, clouded."

Measurements in mm.: Total length of head and body, 75 mm.; head to line of canthus oris, 19; width of head at canthus oris, 28; length of anterior limb, 40; length of head, 18; length of posterior limb, 115; length of hind foot, 50; length of astragalo-calcaneum, 20.

Remarks: "This is the largest species of *Lithodytes,* but it is less robust than the *L. gulosus* Cope. In general appearance it resembles one of the large species of *Leptodactylus,* but it is a true Hylodine, with T-shaped terminal phalanges. It has some resemblance to *L. melanostictus,* but that species has much longer hind limbs, larger pallets, an oval tongue, etc. A single specimen of the *L. euryglossus* is in the collection, which was taken at San José, by Sen. P. Biolley (No. 448)."

I have not been able to recognize this species in the material at hand.

Eleutherodactylus florulentus Cope

Lithodytes florulentus Cope, Proc. Amer. Philos. Soc., vol. 31, Nov. 17, 1893, pp. 336-337 (type locality, Boruca, Costa Rica. G. K. Cherrie coll.).

Diagnosis: Heel not reaching anterior edge of eye-orbit; vomerine tooth-rows close together; digital dilations small; head short, depressed canthus not distinct; tympanum (probably) a vertical oval, about half of the length of eye opening; two metatarsal tubercles; tubercles under fingers flat, less distinct on toes; venter smooth gray, the posterior face of leg black, cross-banded with dark, separated by scarlet areas; posterior sides and anterior abdomen blackish or brownish with crimson or orange spots. Length 35 mm.

Description of species: "The only specimen of the *L. florulentus* is damaged as to the integument of its head, which has been destroyed by agencies unknown to me. The skull with its muscles, and the rest of the body with the integument, are preserved. The head is short and depressed, and the canthus rostralis is not distinct. The length of the muzzle from the nostril to the orbit is about equal to the anteroposterior diameter of the latter, and the nostril is quite near the end of the nose. The tongue is subround, and is a little wider than long in its present condition. The internal nares are well forward; and the vomerine teeth are in two fascicles which are

close together, and are so far posterior to the nares as to be in transverse line with the palatine ridges. They are also as far as their own diameter within the anteroposterior line of the internal nares. The ostia pharyngea are narrow slits about as long as the nares. The tympanic drum is destroyed, but the space for it is a vertical oval, with about half the anteroposterior diameter of the orbit. The heel of the extended hind limb reaches the anterior border of the orbit. The extremital dilations are very small. There is a rather large oval internal or prehallucal tubercle which is entirely sessile; there is a small external tubercle. There are two palmar tubercles, and those of the anterior digits are distinct but flat; those of the posterior digits are less distinct. The integuments of the inferior and concealed surfaces are smooth; on that of the back a few small tubercles are present.

Color: "The color of the upper surfaces is gray dusted with blackish. The inferior or posterior surface of the hind legs is black, and this color is continuous with dark-gray cross-bands which cross the superior faces of the tibia and femur, four over each. The spaces between these cross-bands are scarlet. The posterior part of the sides and anterior part of the abdomen is blackish to brownish with crimson and orange spots of various sizes and shapes, the largest in the groin. Three cross-bands on upperside of foot, and three across forearm. Coloration of head unknown. The only specimen of this handsome species contained in the collection is from Boruca, and is No. 327.

Measurements in mm.: "Total length of head and body, 35; length of head to posterior line of tympanum, 12.5; width of head at posterior line of tympanum, 15; interorbital width, 3.5; length of fore limb 20; length of fore foot, 9; length of hind limb from groin, 51; length of hind foot, 24; length of tarsus, 9."

Remarks: I have not examined a specimen of this form. I doubt that it has been retaken.

Eleutherodactylus gaigei (Dunn)

Lithodytes gaigei Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 387-388 (type locality Fort Randolph, Panamá Canal Zone. Also reported from Barro Colorado Island, Canal Zone; and Talamanca Valley, Costa Rica. The species is named for Mrs. Helen Gaige. Perhaps the name should be corrected to *gaigeae.*); *idem, ibid.* Oct. 10, 1931, p. 410; *ibid.* vol. 8, June 7, 1933, p. 67 (El Valle de Anton, Panamá).

Diagnosis: Related to *Lithodytes lineatus* of South America but differing in having head wider than body; no flash markings on thigh or in groin; vomerine teeth oblique rather than transverse; dorsolateral light line from eye to sacrum.

Description of type: "M.C.Z. no. 10011: head a rather pointed oval; snout flat above, pointed; canthus rostralis angular; lores sloping steeply; upper eyelid less than interorbital diameter; eye equal to its distance from nostril; tympanum ½ eye; heel to between snout and eye; head wider than body; disks of fingers and toes equal, about half again diameter of digit, much smaller than tympanum; fingers and toes free; a large inner and small outer metatarsal tubercle; a tarsal fold; finger I about equal to finger II; toe III equal to toe IV; smooth below, uniformly and finely rugose above; vomerine teeth in two oblique groups, equally in and back from choanae, separated by diameter of choanae and distant from choanae by same distance; dark brown, lighter below; a light line from eye to sacrum, snout to vent 38 mm."

Remarks: Dunn reports two small specimens from Talamanca, M.C.Z. Nos. 9901, 9904, 21 mm. and 18 mm. long, respectively. "They are black above, slightly lighter below, and the dorsolateral light lines begin on the snout where they meet. The vomerine teeth cannot be made out. In one the first and second fingers are equal and the third toe is shorter than the fifth, in the other the first finger is the shorter and the third toe is equal to the fifth."

I have not found this species in Costa Rica. I have examined the female type of this species but have not dissected it. The following characters were noted: choanae distinct, somewhat rounded; the vomerine teeth in two diagonal (not transverse) series, beginning anterior to back level of choanae converging somewhat, separated from each other by a distance greater than their distance from choanae; tongue largely free behind; snout rather long; the width of an eyelid about equal to interorbital space; diameter of tympanum contained approximately 1⅓ times in length of eye.

First finger a little longer than second; hand with four supernumerary tubercles, six on foot; metacarpal tubercle rounded, distinct; palmar tubercle completely divided, the medial portion elongate; foot with trace of webbing; discs small; a large inner metatarsal tubercle, outer less than half as large; no fold evident on tarsus. Color blackish with thin dorsolateral white lines; whole underside cinnamon-brown.

FAMILY CENTROLENIDAE Taylor

Centrolenidae Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 36.

This recently proposed family of frogs extends in the Western Hemisphere from Central Veracruz and Guerrero in Mexico, to Perú and Argentina in South America. The members of the family

may readily be recognized by the presence of a single bone in the third (tarsal) segment of the hind leg. This is the result of the fusion of the astragalus and calcaneum into a single elongate element, similar to the fusion of the tibia and fibula in the adjoining segment.

One may postulate that the original, primitive condition is the separation of these bones into two elements. One would then conclude that the Centrolenidae represent a group that has relatively recently developed this character and are highly specialized. The tarsal characteristics of the ancestors of the present day Salientia is not known with certainty, but the oldest known Salientia have completed the fusion of the radius and ulna, as well as that of the tibia and fibula, and a fusion of the elements of the urostyle. An American fossil species, tentatively referred to the family Pelodytidae, also displays a fusion of the astragalus and calcaneus. Whether or not this ancient process of fusion once begun, extended to the tarsal elements in the ancestral salientian form, is not known, but it may be regarded as probable. The loss of the tail and the assumption of the leaping habit may conceivably have been the selective factors responsible for the re-separation of the two elements. This latter suggestion may not be sound, since to be fact, it would appear to demand the reversibility of an evolutionary process.

The Central American species of this family usually are green in life with or without indistinct markings of dark or lighter color on the dorsal exposed surfaces. The ventral surfaces are flesh or whitish flesh, the whole skin of the venter often being so transparent as to permit the discernment of the viscera. When placed in preserving fluids, the green disappears in a short time and a lavender or purplish pigmentation becomes evident on the dorsal surface of the body. This pigment may be equally distributed, or small, rounded, lighter spots, with little or no pigment, may be in evidence; the pigment may be segregated into small spots, or the groupings of the chromatophores may cause a pattern to be formed. The chromatophores vary in size and may disappear after a long time in preservation.

The black or white covering (tunic) of the eyeball visible through the upper eyelid, causes the lid to appear dark or light as the case may be.

KEY TO THE GENERA OF THE CENTROLENIDAE

1. Small species having a free tip on the pollex rudiment, with a spine emerging from it in the male. Costa Rica, Canal Zone, Panamá, *Teratohyla*

2. Males with a process or "hook" on humerus visible externally; vomerine teeth usually present. Central America and northwestern South America ..... *Centrolene*

Males lacking the humeral process; vomerine teeth present or absent. Southern Mexico, Central and South America.... *Cochranella*

Genus CENTROLENE Jiménez de la Espada

Centrolene Jiménez de la Espada, An. Soc. Española Hist. Nat., vol. 1, 1872, p. 87.

Type of genus: *Centrolene geckoideum* Jimenéz de la Espada.

A single species, *Centrolene prosoblepon,* belonging to this genus is known from Costa Rica. Its range is from 5,500 feet on Volcán Poás, to little above sea level near Limón, the type locality. Specimens have also been reported from Canal Zone and Panamá.

The type locality of *Hyla punctierus* is La Palma, Costa Rica, but until this type is compared by a competent observer with *prosoblepon,* it cannot be certain that the species should be regarded as synonyms.

Other known species of the genus are South American in distribution, the type of the genus being the largest known member of the family.

The curious humeral process, present in males of this genus is probably not normally present in females, although the condition has been reported in certain individuals.

Centrolene prosoblepon (Boettger)

Hyla prosoblepon Boettger, Katalog der Batrachier . . . Sammlung, im Museum der Senckenbergischen Naturforschenden Gesellschaft in Frankfurt am Main, Aug., 1892, p. 45 (type locality, Plantage Cairo [La Junta], near Limón, Caribbean side of Costa Rica. Carl Fleischmann coll.); Günther, Biologia Centrali-Americana. Reptilia and Batrachia, 1901, p. 280; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 256 (Costa Rica, Panamá).

Centrolene prosoblepon Noble, Proc. Biol. Soc. Washington, vol. 37, 1925, pp. 66-71 (numerous Costa Rican localities); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 398-399; *ibid.*, Oct. 10, 1931, pp. 415, 421. (Barro Colorado Island, Canal Zone); *ibid.*, vol. 8, June 7, 1933, pp. 73, 74; Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 258-259 (Isla Bonita, Volcán Poás, Costa Rica).

? *Hylella punctierus* Boulenger, Ann. Mag. Nat. Hist., ser. 6, vol. 18, 1896, p. 341 (type locality La Palma, Costa Rica, C. F. Underwood coll. Snout-to-vent length 26 mm.).

Diagnosis: A small frog, snout to vent, 26 mm.; green in life with the venter transparent flesh permitting a view of internal organs; tips of digits dilated into distinct disks, wider than fingers or toes, the tip rounded rather than truncate; vomerine teeth present; males with a humeral process or hook, not indicated in females; no web between first three fingers; between third and fourth about one

half webbed; heel to near nostril; smooth above, granular on venter; chin and breast smooth; interorbital distance equals eyelid; tympanum distinct, directed outward and slightly upward and backward; a pair of rounded moundlike tubercles on ventral side of thighs near the median line; a thickened tarsal fold; males with a large lateral somewhat diffuse gland. Males often with numerous minute white-tipped spinules on side of head and neck (probably a breeding phenomenon). Nearly uniform heliotrope or reddish lavender, with small rounded darker dots on limbs and posterior part of back (sometimes lacking on back).

Description of species: (K.U.M.N.H. No. 23806, Isla Bonita, Volcán Poás, 5500 ft.). Head length (9 mm.) less than head width (9.5 mm.); eyes large, strongly protruding directed somewhat forward; the eyelid equal to interorbital width (2 mm.); canthus rostralis distinct, rounding; areas about nostrils swollen with a depression between them extending length of snout; nostrils nearly terminal, but not extending forward to level of lip; tympanum distinct save that the upper part is covered by a thickened indistinct skin fold, its diameter (1.1 mm.) contained in eye length (3.8 mm.) 3.4 times; loreal region somewhat concave, sloping obliquely to lip; distance between tympanum and eye twice width of tympanum; length of eye (3.8 mm.) greater than snout length (2.8 mm.); nostril nearer median point of upper lip than to eye.

Tongue longer than wide, less than one fifth free behind; (vocal sacs elongate in males); choanae rather large, longer than wide, the width of one in distance between them approximately four times; vomerine teeth in two somewhat diagonal fasciculi, lying between choanae, separated mesially by a distance nearly equal to distance separating them from choanae; transverse groove of the palatal glands nearly straight, nearer choanae than anterior part of palate.

Arm strong, the hand large; fingers with terminal discs distinctly wider than digits; first finger distinctly longer than second, lacking traces of web between first three fingers; one-third webbed between outer fingers, with a slight fringe continuing to disc; inner metacarpal tubercle moderate without free tip or spine; humerus without hook (present in males); median palmar tubercle strongly defined, rounded.

Leg elongate the heel reaching approximately to nostril; discs on toes smaller than those on fingers, and that on first finger is somewhat pointed; other digits nearly truncate but slightly curving on ends; outer toes with web extending two thirds length of third and

fifth; first and second less than half webbed; elbow and knee overlap but if legs are folded the heels touch but do not overlap.

Skin smooth on dorsal and lateral surfaces save for some minute white-tipped tubercles below tympanic area; chin, breast, and underside of arms smooth, venter granular; much of the posterior part of ventral surface of thigh granular with a pair of large, moundlike tubercles near median line; some indistinct vertical wrinkles below anal region.

Color: Greenish in life on dorsal surfaces; ventrally yellow to transparent flesh; in preservation heavily pigmented with purplish lavender, the chromatophores segregated in places to form spots (which may be scattered on back and limbs); pigment less distinct above arms and legs but spots also present; ventral and concealed surfaces whitish flesh; concealed parts of eyeball blackish, thus leaving dark eyelids.

Measurements of Centrolene prosoblepon (Boettger)

		Total length	Head length	Head width	Arm	Hand and fingers	Leg	Foot and toe	Tibia	Femur
23806	♀	27.5	9	9.5	18	8.5	46	20	15	15
793°	♀	26.5	9	9.8	16	10	46.2	20	15.2	15
2922	♂	26.5	8.4	9.2	18	8	46	19	14.6	13
23804	♂	26	8.3	9	17	8	46	19.4	14.6	13
2926	♂	25	8.3	9	17	8	46	19	14.4	14
23803	♂	25	8.2	9	16	8	45	19	14.2	13.8
23805	♂	24	8	8.5	17.5	7.9	43	19	14	12.8
794	♂	23.4	7.9	8.5	17	7.8	43	19	14	13
Type	..	24.5	7.5	9	14.5	..	42	..	..	..

Remarks: A series of eight specimens from Isla Bonita (The American Cinchona Plantation), display varying shades of lavender, and different degrees of spotting.) Two females, the largest specimens, have the darkest shade of lavender. The exposed surfaces of the back and limbs have small, rounded, purplish or purplish-brown spots. The males, which on the whole are of a light shade of lavender, have the spotting similar to that in the females in two specimens, while in four the spots are fewer in number and confined to the rump and dorsal surfaces of the limbs.

The largest male, with a very well-developed humeral process, has no trace of vomerine teeth; but they are present in all other specimens examined. The two females show no trace of the humeral process.

° Nos. 793, 794, 2922, 2926 are field numbers of R. C. Taylor; others are K.U.M.N.H., all from Isla Bonita, Volcán Poás.

The measurements of the type, as recorded in the type description, is appended to the table of measurements. It may be noted that the measurement of the arm of the type is considerably smaller than that of specimens of smaller snout-to-vent measurement in this series; the leg is slightly smaller, the head length a little shorter, and the head width a little greater. The differences may be due to a different technique of measurement.

The type is from near sea level while the specimens listed in the table come from an elevation of about 5,500 ft. on Volcán Poás. Whether or not direct comparison with the sea level population would reveal other significant differences cannot be stated now.

A single specimen was taken in 1951 at Moravia; the vomerine tooth fasciculi are present. Externally the vocal sac is evidenced by two small pouches which seemingly are separated. The spotting is sparse and confined largely to limbs and posterior part of dorsum. The head and remainder of the back are uniform purplish lavender.

Genus TERATOHYLA Taylor

Teratohyla Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, p. 35.

Type of genus: *Centrolenella spinosa* Taylor.

A single species is known. It is related to other members of the family as *Plectrohyla* and *Hypsiboas* are to *Hyla*. The only species reaches a known length of approximately 21 mm. No females have been found, but it is to be expected that their size is two or three millimeters larger than males. The present known range extends from Costa Rica on the east slope, to Panamá and the Canal Zone.

Teratohyla spinosa (Taylor)

Figure 35a

Centrolenella spinosa Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 259-262 (type locality, Los Diamantes near Guápiles, Costa Rica. R. C. Taylor and E. H. Taylor colls.).

Teratohyla spinosa Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, p. 35.

Diagnosis: A small species (about 21 mm.); snout high, the front edge nearly vertical; nostril near front edge of snout. Vomerine teeth very weak, usually present; tympanum present; skin minutely rugose but not granular on back and sides; a well-defined pollex-rudiment bearing a sharp spine which may or may not be exposed; lavender without any spotting; eyelids purple; iris silver with purple reticulation; inner toe narrowed at tip.

Description of the type: Head broader than the body; eyes prominent, directed somewhat forward; canthus rostralis apparent, very

much rounded; areas about nostrils much swollen with a distinct medial depression between them; loreal region with a long slope to lip, the area behind nostril slightly concave; snout in front of nostrils nearly vertical, the nostrils much nearer median point of upper lip than eye; interorbital width greater than the length of snout, one and three-fourths times width of an eyelid; tympanum present, its greatest diameter about one and three-fourths times in its distance from eye, almost three times in longitudinal diameter of eye; a rather marked constriction of head behind tympanum, with a somewhat swollen area above arm insertion; supratympanic fold

FIG. 35a. *Teratohyla spinosa* (Taylor). Type K.U.M. N.H. No. 23809 ♂; Los Diamantes, Costa Rica; actual snout-to-vent length, approximately 20 mm.

obsolete; tongue rather rounded with a scarcely discernible notch behind, free behind for about one fifth its length; openings to vocal sacs elongate, curved slits, beginning along sides of tongue and extending some distance behind; choanae large, round, the diameter of one contained in distance between them three times; external vocal sac forming ample folds on chin.

Upper arm very slender, the forearm greatly thickened with an indistinct flattened skin-fold on under surface; only a faint trace of web between the first and second fingers; a small but distinguishable web between the second and third with a moderate fringe reaching terminal pad on outside of second finger; third and fourth fingers about half webbed, the web not reaching the level

of the outer subarticular tubercles; fingers widened at tips, and more or less truncate; first finger much longer than second with a distinct rudiment of pollex, free at tip, with a sharp, strong spine (possibly absent in female; none seen); pollex surrounded by the elongate palmar tubercle; a strongly defined, rounded, median, palmar tubercle; subarticular tubercles well defined and numerous; supernumerary tubercles present; legs long, the tibiotarsal articulation reaching slightly beyond snout-tip when limb is adpressed; the heels touch but do not overlap; foot a little more than three fourths webbed, the terminal pads smaller than those on fingers, the outer somewhat truncate, that on inner toe somewhat pointed, scarcely or not as wide as toe; moderate inner metatarsal tubercle elevated but little; apparently no trace of an outer tubercle; subarticular tubercles small, supernumerary tubercles not or scarcely discernible; inner tarsal fold very weak, scarcely discernible; anal opening high on rump covered by a free flap, the transverse free edge much longer than width of flap.

Skin on back and sides seen under a lens, minutely rugose, but definitely not granular; belly and under side of thigh strongly granular, the granules of the latter much the larger.

Color: In life, yellow-green except concealed surfaces of arm, leg, and under side of body which are flesh-white, and transparent, without markings; a large light cream spot in front of arm insertion. In preservative (formalin, then alcohol) the dorsum nearly uniform lavender, the eyelids deep purple; limbs lighter but with a fine peppering of lavender chromatophores on the exposed surface, even on upper surface of the thigh; below and on concealed surfaces pure white without pigment; iris of eye silver with purple venation; upper lip white.

Measurements in mm.: Snout to vent, 20; width of head, 7; arm, 13; leg, 35.5; axilla to groin, 10.2.

Variation: The five paratypes are all males and agree with the type in essential details, such as in the constriction of sides of head behind the tympanum, forward position of nostril, and the narrow tips of inner toes; the vomerine teeth appear to be present in all but are completely transparent and scarcely discernible save under magnification.

The spine of the pollex is transparent, sharp, and in certain cases, does not seem to have pierced the surface of the skin. I presume that this serves as a "grasping" organ in clasping and that the spine pierces the skin surrounding it during this act. If the spine is present in the female it will probably be found to be much reduced. The base of the first finger lacks nuptial asperities although under

a lens one can discern a group of small spherical glands below the skin in the region where they normally occur in certain other species.

This genus stands in relation to *Cochranella* much as *Plectrohyla* does to *Hyla*.

Specimens were taken at night during a rain. They were calling from plants along a forest rivulet.

Genus COCHRANELLA Taylor

Cochranella Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, pp. 34-35.

Type of the genus: *Centrolenella granulosa* Taylor.

Eight species are recognized in Costa Rica. All these are diminutive frogs not known to reach a size greater than 28 mm. Most of them are greenish in life on the dorsal surfaces of body and limbs, while the venter may be cream, white, yellow or transparent flesh. They are found perched on leaves of trees or plants near running water. Eggs are probably always laid on leaves above water, and this is certainly known to be the case in two members of the genus.

One specimen taken during the daytime was found attached to the under side of a leaf surrounded by a mucouslike covering. Eggs were found above the water on leaves of *Bryophyllum* or other plants growing along the edges of small rivulets.

KEY TO COSTA RICAN SPECIES OF COCHRANELLA

1. Vomerine teeth absent 2
   Vomerine teeth present 6
2. Area about nostrils not swollen, not projecting beyond lip; tympanum hidden; no web between first two fingers; heel not reaching beyond tip of snout 3
   Area about nostrils swollen, not, or more or less, projecting; heel reaches beyond tip of snout; tympanum visible 4
3. Cover of eyeball black, the upper eyelid appearing dark; heel reaching tip of snout. San José and Alajuela . . . . . *chrysops*
   Cover of eyeball white; upper eyelid appearing largely white; heel reaching to anterior edge of eye; diameter of the choanae in distance between choanae about three times. Central America to Mexico . . . . . *fleischmanni*
4. Tympanum small ⅓ to ⅙ of eye length; snout strongly projecting, a green median stripe. Costa Rica . . . . . *valerioi*
   Tympanum larger, its upper edge may be indistinct, its diameter in eye contained 2.5 times or less 5
5. Tunic of eye light; a greenish median line present with series of small rounded light spots more or less arranged in rows; no strong folds behind vent. Choanae moderate. Moravia, Costa Rica . . . . . *talamancae*

Tunic of eye dark, strong folds on thighs below or behind vent; no dorsal stripe or defined white dots ..... *colymbiphyllum*

6. Skin on dorsum smooth; tympanum "small"; no web between first two fingers; outer finger about four fifths webbed; toes completely webbed; nostril?; tip of snout?; dorsum with minute dark flecks and scattered white punctations. Reported from Bebedero and Turrialba ..... *pulverata*

Skin on dorsum more or less granular; nostril equidistant or nearer to eye than median edge of lip; vomerine teeth weakly developed; tip of snout sloping forward obliquely 7

7. Skin of dorsum strongly and regularly granular; web remnant between first and second fingers; outer fingers two thirds webbed; toes three fourths webbed; eyelid purple; body (in alcohol) creamy white with numerous fine chromatophores and numerous larger punctations of dark purple; 28 mm. Los Diamantes ..... *granulosa*

Skin of dorsum indistinctly granular on posterior part, slightly rugose on sides and head; vomerine teeth strongly developed; heel 4-5 mm. beyond tip of snout; eyelid equals interorbital width; purplish lavender above with numerous rounded cream or white spots; 27 mm. Los Diamantes ..... *albomaculata*

Cochranella chrysops (Cope)

Hylella chrysops Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, p. 196 (type locality, Alajuela, Costa Rica, R. Alfaro, coll. and San José, Costa Rica, P. Biolley coll.) (Here restricted to San José, Costa Rica.)
Cochranella chrysops Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 35.

This species, which in the more recent literature has been placed in the synonymy of *Centrolenella fleischmanni* Boettger, is, I suspect, a species distinct from *fleischmanni*. One of the most striking characteristics of the latter is the white covering of the concealed parts of the eyeball which produces a silvery white or cream white marking through the upper eyelid. In *chrysops* the covering of the eyeball is dark, and the upper eyelid appears dark because it is semitransparent; a comparison of specimens of the two forms shows the legs of *fleischmanni* slightly longer, reaching the tip of the snout or usually a little beyond tip. There are no vomerine teeth. Cope's original description follows:

Description of type: "Head short, wide, canthus rostralis wanting. Tongue a little longer than wide, faintly emarginate; ostia pharyngea each a transverse slit. Tympanum not visible. Pupil a dumb-bell-shaped horizontal slit in the golden iris. Heel of extended hind limb reaching to end of muzzle. The muzzle is as long as the diameter of the eye, and does not project beyond the lips; nostrils terminal. The fingers are one-third webbed, the thumb free, and at least as long as the short third (second) digit. Hallucal tubercle minute; pallets well developed.

Color: "Above and below yellow; pigment more conspicuous on edges of eyelids. No markings of any kind except that one specimen is covered above with rather distinct, minute, black specks."

Measurements in mm.: Total length, 22; head to mouth angle, 6; width of head, 8; arm, 13.5; hand, 6; leg, 36; foot, 15; tarsus, 7.

Remarks: Cope compares his species with *Hylella platycephala* (= *sumichrasti*) of Mexico; but it is not related to that species. The relationship of *chrysops* is presumably with *fleischmanni* which likewise has the tympanum concealed.

From *colymbiphyllum*[*] it differs in having the tympanum concealed, a narrower interorbital interval in comparison to the width of an eyelid (in *chrysops* the eyelid is contained twice or slightly less than twice in this distance, while in *colymbiphyllum* 1.25 times); the areas about nostrils are not conspicuously swollen. *Chrysops* is a smaller species (maximum seen, 23.5 mm.).

Cope states that the specimens are yellow above and below. If this color is that of living specimens, this will constitute another difference between *chrysops* and *fleischmanni*. However, I suspect that they are green in life, as are most if not all other Costa Rican species of this genus.

During the summer of 1951 I spent some time in the region about Alejuela and Río Segundo in hopes of obtaining specimens of this form, but my efforts were of no avail.

Cochranella fleischmanni (Boettger)

Hylella fleischmanni Boettger, Senckenberg Naturf. Gesellsch. 1893, pp. 251-253 (type locality, San José, Costa Rica, Carl Fleischmann coll.); Boulenger, Zool. Rec. 1894, Rept. p. 41; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 287, pl. 73, fig. D (San José, La Palma, Alajuela); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 255; Taylor, Univ. Kansas Sci. Bull., vol. 28, pt. 1, May 15, 1942, p. 74; Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, p. 601 (Salto de Agua, Chiapas, Mexico.).

Centrolenella fleischmanni Noble, Proc. Biol. Soc. Washington, vol. 37, 1924, p. 69; Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, 1949, pp. 264, 265.

Cochranella fleischmanni Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 34.

Diagnosis: A small species (22 mm.-25 mm.), with rounded snout and without canthus rostralis; tympanum completely concealed; no vomerine teeth, nostrils not swollen; green in life, with a cream-white to golden yellow area covering eyelid and concealed parts of eyeball; chromatophores scattered over the flesh-colored dorsum in preserved specimens; without web between first two fingers; small web at base between second and third; outer toes half

[*] The diving leaf.

webbed; skin smooth or granular (?). The white spot above eye is not lost in preservation. Vomerine teeth absent.

Description of species: (K.U.M.N.H. No. 23807.) Head width (9 mm.) greater than its length (7 mm.), the head definitely rounded in profile seen from above, the nostrils barely breaking the outline of the jaw; tympanum concealed, rarely visible when specimens are shrunken or dried; canthus rostralis absent (or very broadly rounded), the loreal region concave and sloping to edge of lip; eye large, directed considerably forward, its length (2.3 mm.) greater than snout length (2.1 mm.); nostrils closer to median point on lip than to eye not projecting when seen in lateral profile, the front of the snout almost vertical to lip, not sloping obliquely; width of an eyelid (1.1 mm.) in interorbital width (2.4 mm.) more than twice; a slight depression indicated between orbits; iris of eye clouded with purple. Choanae circular the diameter of one (.6 mm.) in distance between them (1.8 mm.) three times; no vomerine teeth; choanae of about same size as the openings of the Eustachian tubes; a sharp ridge borders anterior outer edge of the groove leaving the choanae; tongue a little broader than long not emarginate behind, free for about one sixth of its length; vocal slits large, elongate.

Arm rather long the fingers widened and truncate, with terminal discs not or scarcely wider than digit; first finger distinctly longer than second, none or but slight trace of a web between first and second finger; between second and third about one third webbed the web continued as a broad fringe to disk on the outer side of second finger; outer fingers less than half webbed, the broad fringe continuing to the disc on the outer side of third finger; inner metacarpal tubercle elongate, flattened, without free tip or spine; median palmar tubercle well defined, circular; a distinct skin fold along outer ventral arm surface; subarticular tubercles well defined, none divided; numerous granulations on under side of hand.

Leg elongate the heel reaching a point immediately in front of eye; a sharply defined inner tarsal fold; and an indistinct outer fold may be present along part of the tarsus; toe discs smaller than those on fingers; toes two thirds webbed; inner metatarsal tubercle flat; outer tubercle small but distinct; when legs are folded at right angles to body, heels barely touch or fail to touch.

Skin above smooth but under lens shows fine granulation on dorsum and sides as well as on arms and parts of upper side of legs; a very ample smooth vocal sac on chin; breast smooth with a breast

fold indicated (males); venter coarsely granular, as is part of underside of femur where a few very large flat granules are present near median line; anal opening high, the area below vent somewhat wrinkled and granular.

Color: Greenish above in life with a creamy or yellowish-white spot on eyelid (actually the coloring is on the eyeball and not the skin). Below transparent flesh. In preservation body flesh-color with fine purple chromatophores scattered on dorsal surfaces and side of head; venter and concealed surfaces flesh color.

Measurements in mm.: Snout to vent, 24; snout to eye, 2.1; width of head, 9; length of head, 7; eye length, 2.3; arm, 14.3; hand, 7.2; leg, 39; tibia, 12.5; foot and tarsus, 16.

Remarks: This species has been traced north into Mexico. Most of the northern collections have been of single, or of very few, individuals. It is uncertain whether any significant differential characters obtain in the northern populations.

Eggs, of what was presumed to be this species, were acquired from a small shrub, growing over a small drainage ditch near Cartago, at an elevation of nine feet from the ground; adults of *fleischmanni* were taken in the immediate vicinity. The eggs are smeared over the surface of a partly folded leaf covering an oval surface 20 mm. long, 17 mm. wide, the individual eggs probably averaging 1.5 mm. in diameter. The mass includes a total of 53 eggs, all lying in the same plane. The eggs seemingly had just been deposited. Several other egg lots were observed on *Bryophyllum* growing on the edge of a small rivulet.

Three specimens were taken at Río Segundo, Costa Rica and others at Cartago. A dried specimen taken near Empalme by Mr. Jack Reark and presented to me, is believed to belong to this species.

One recently transformed specimen taken at Turrialba is also presumed to belong to this species, but this at best is uncertain. The largest specimen, a male from Río Segundo, measures 25 mm. On each side of the neck are enlarged swellings immediately above arm insertions. None of the other specimens taken there show such a development. Save for size I find no other pertinent differences.

Cochranella valerioi (Dunn)

Centrolene valerioi Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 18, 1931, pp. 397-400 (type locality, La Palma, Costa Rica. Manuel Valerio and E. R. Dunn, colls.); *idem*, vol. 8, June 7, 1933; ? Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 264-265.

Cochranella valerioi Taylor, Proc. Biol. Soc. Washington, vol. 64, April 13, 1951, p. 35.

Diagnosis: Vomerine teeth absent; nostrils swollen, protruding; snout projects in front of mouth; tympanum small, indistinct, covered with skin but more or less visible under skin; fingers ⅓ to ½ webbed; foot nearly ⅔ webbed; heel to a point 2 mm. beyond tip of snout; vocal slits very short; maximum known size 21 mm.

Description of species: (From paratype MCZ. 16004, topotype.) Head (8 mm.) distinctly broader than body, and likewise greater than length of head (6.6 mm.); eyes very large the diameter (length) (2.8 mm.) greater than length of snout (2.1 mm.); distance between eye and nostril 2 mm.; distance of nostril to median point on upper lip 1.8 mm; canthus distinct but somewhat rounded, the loreal region concave, sloping obliquely to mouth; width of eyelid (1.5 mm.) in interorbital distance (2.3 mm.) one and one-half times; swellings about nostrils prominent, terminal, projecting, with a slight depression present dorsally and anterially between them, the nostrils actually in advance of the line of mouth; typanum completely covered with skin, directed upward; when skin is lifted, the tympanum is of moderate size, its greatest diameter (.9 mm.) about a third of eye length; area between orbits somewhat concave. Vomerine teeth absent; choanae moderately large, longer than wide, the width of one (.5 mm.) contained in the distance between them (1.5 mm.), 3 times; tongue subcircular, thick, slightly broader than long, free behind for about one fourth of its length; vocal slits, small, nearly transverse; openings of Eustachian tubes less than half size of choanae.

Arm with wrist extending considerably beyond tip of snout; no axillary web. Fingers with slightly widened discs, truncate at tips; first finger a trifle longer than second, the web between first and second fingers about one fourth of their length; between second and third about one third the length of second; third and fourth toes webbed nearly one half length of fourth, but there is a strong fringe continued to the terminal phalanges of each; inner metacarpal tubercle slender elongate but lacking a free tip and spine; median palmar tubercle distinct oval, relatively small.

Leg long, the heel reaching beyond tip of snout, the elbow and knee overlap, but the heels where legs are folded barely touch; inner metatarsal tubercle elongate, inconspicuous; outer tubercle seemingly obsolete; toes webbed approximately two thirds of their length with a fringe continued to terminal phalanges on the inner side; no tarsal fold present.

Skin on head, dorsum, sides, chin, and breast smooth; venter finely granular on anterior part, coarsely granular posteriorly with

some indication of granulation on posterior median part of ventral surface of thighs; vent high on thigh with a short wide anal flap; skin below anus longitudinally (vertically) folded but the folds indistinct.

Color: Flesh white with practically no trace of pigment visible at the present time.

Measurements in mm. of type and paratype of Cochranella valerioi (Dunn)

	Type	Paratype
Snout to vent	21	20.8
Width of head	8	8
Length of head	..	6.6
Length of eye	..	2.8
Length of snout	..	2.1
Arm	13	14.2
Hand	..	6.2
Leg	39	38
Tibia	..	13
Tarsus and foot	..	16.5

Remarks: The coloration of the type is given as follows: "In life white, a narrow green dorsal stripe, green vermiculations on dorsal surface and on shin, thigh unpigmented, white beneath, iris golden; in preservative white, a few faint dark chromatophores where green was in life."

Differences between this specimen and the type are not marked but what seem to be differences may be due to other reasons. The tympanum is stated to be one sixth of eye, but I suspect that the measurement was made without removing the skin which covers it.

Cochranella talamancae sp. nov.

Type: K.U.M.N.H. No. 4143. Moravia, Costa Rica, Caribbean drainage; August 16, 1951, Edward H. Taylor, collector.

Diagnosis: Snout sloping abruptly to edge of lip but not extending beyond; vomerine teeth absent; tympanum present, more or less covered by skin but distinctly visible, largely directed upward; a whitish bar across head at narrowest point between orbits; general color greenish yellow with a reticulation of green, the green surrounding small rounded light spots more or less distinctly arranged in eight or nine linear series; a more or less distinct greenish median line; no anal tubercles or ridges; the bones are not green; eye surrounded by a white tunic.

Description of type: Small species (22 mm. ♂); head much broader than body; snout truncate; head much wider than long

with the large eye largely directly forward; tympanum distinct, covered with thin skin, its diameter in length of eye approximately 2.8 times; the distance between tympanum and eye distinctly greater than diameter of tympanum; length of eye distinctly greater than length of snout; top of head rather flat, sloping down slightly to base of snout; areas about nostrils swollen with a distinct depression between; nostrils nearly terminal but not extending beyond the lip, a little closer to median point on lip than to eye; canthus more or less distinct, straight; eyelids narrow, contained in interorbital interval twice; choanae large, the diameter of one (.7 mm.) in distance between choanae (1.3 mm.) less than two times; no vomerine teeth; tongue a little broader than long, only the posterior edge free; vocal slits short, largely posterior to tongue and lying mediad a considerable distance from jaw.

Arm very slender, digits broad, rather truncate, the first finger longer than second; a small web between the first and second and second and third, with a narrow fringe reaching to discs on the outer edges of fingers; the web between the third and fourth fingers continues as a fine fringe on each digit, but web deeply excised between them (a little more than one third webbed); inner carpal tubercle discernible; a rounded palmar tubercle; other tubercles on digits and palms scarcely discernible.

Leg slender with a fused astragalus and calcaneum; a flat inner metatarsal tubercle; outer not distinguishable; toes a little more than three-fourths webbed, the tips slightly rounded; tips or discs of all digits equal to or less than width of digit. Tibiotarsal articulation to tip of snout; legs folded at right angles to the body, heels do not touch; elbow and knee overlap 2.5 mm.; a slight tarsal fold.

Skin above appearing smooth but under lens is minutely rugose; sides indistinctly granular; venter except breast and chin evenly granular; under surface of thigh with irregular granules; no especial folds or tubercles in region of vent.

Color in life: Above, the ground color is generally yellowish green to greenish yellow with a more or less distinct median green line, and a green reticulum that forms eight or nine more or less distinct but somewhat irregular linear series of rounded light spots; hands and feet flesh, with very slight yellowish wash; eye with a gold rim; iris reticulated purplish black and golden; below on venter greenish flesh, transparent so as to show details of viscera; an area on chin whitish flesh.

In preservative the green has wholly disappeared and a large number of purplish or lavender chromatophores are in evidence.

These are not equally distributed but leave numerous unpigmented light areas; golden band on eye-rim cream-white; upper eyelid purple and white; iris lavender with some whitish flecks.

Measurements in mm.: Snout to vent, 22; width of head, 8.6; length of head, 6.2; length of eye, 2.5; diameter of tympanum, .9; length of snout, 2; eye to nostril, 1.9; nostril to median point on lip, 1.75; width of an eyelid, 1.3; interorbital interval, 2.7; arm, 15; hand, 7; leg, 37; tibia, 12.2; foot and tarsus, 16.2.

Remarks: This species is seemingly most closely related to *Cochranella valerioi* but differs in having less webbing on feet and hands, a snout that does not have nostrils extend in advance of the lip, a wider interorbital distance, the thigh pigmented above and a somewhat larger tympanum.

The specimen was taken at night on a leafy plant growing out from the bank and over a small rivulet. The call is a low whistle.

Cochranella colymbiphyllum (Taylor)

Figure 36

Centrolenella colymbiphyllum Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 262-263 (type locality, American Cinchona Plantation [Isla Bonita] Caribbean drainage of Volcán Poás, Costa Rica; R. C. Taylor and E. H. Taylor colls.).

Cochranella colymbiphyllum Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 34.

Diagnosis: Tympanum moderately distinct, its diameter, in diameter of eye, at least 2.5 times; width of an eyelid in narrowest interorbital width, 1.25 times; frontal region shallowly concave, the areas about nostrils strongly swollen with a depression between; canthus indistinct, concave; skin below anal opening forming vertical folds extending under median part of thighs; tibiotarsal articulation to tip of snout or beyond snout; terminal disks of hand wider than digits; fingers less than one-half webbed; choanae large, the diameter of one contained in distance between them slightly less than two times; no trace of a humeral process; no free pollex rudiment; vomerine teeth absent.

Description of type: (K.U.M.N.H. No. 23812.) Adult male; vocal sac forms ample folds on chin and throat; head a little broader than body; eyes prominent, directed forward; rounded outline of jaw seen from above interrupted by snout which extends a little farther forward than edge of mouth; interorbital width small, about one fourth greater than width of an eyelid, slightly greater than distance between eye and nostril; frontal region slightly concave; the canthus rostralis indistinct, strongly concave; lores oblique, not or but very slightly concave; nostril distinctly nearer median edge

of lip than eye; a distinct depression between the swollen areas of nostrils; eyeball purplish black, the color showing through eyelids so they appear dark; lower part of tympanum distinct, largely directed upward but apparently covered with thin slightly pigmented skin, the inner edge more heavily covered.

Tongue subcircular, more or less emarginate on posterior edge, free only for about one sixth of its length; openings to vocal sac elongate slits extending along sides of tongue and somewhat be-

FIG. 36. *Cochranella colymbiphyllum* Taylor. Type K. U. M. N. H. No. 23812; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 26 mm.

hind; choanae very large, their diameter slightly more than half distance between them; vomerine teeth absent.

Upper part of arm very slender, forearm thickened with a strong fold on its outer edge, without a thin flap indicated at elbow; median palmar tubercle very distinct; inner tubercle rather indistinct, lacking nuptial rugosities but with the minute glandules visible under the skin; toes broad, terminal discs distinctly wider than digits, the width of outer finger disk equal to half eye diameter; outer fingers little more than one-third webbed; a trace of web between first two fingers. Leg elongate, the tibiotarsal articulation reaching 2 mm. beyond tip of snout; heels barely touch when

legs are folded at right angles to the body; a flat rather large inner metatarsal tubercle; outer tubercle if present very indistinct; toes nearly three-fourths webbed except that first two have webs extending scarcely half their length.

Skin not granular, but under lens some very minute elevations visible, each with a medial depression suggesting a crater; chin and throat smooth; abdomen areolate; a very small areolate area on under surface of thigh; skin below anus forming vertical folds, noticeable when femurs are at right angles to body.

Color: In life, uniform bright yellow-green on back and sides, with dim suggestions of cream flecks; on ventral surfaces whitish, semitransparent; tips of toes yellowish. In preservative (formalin transferred to alcohol), nearly white with numerous star-shaped chromatophores and indications of small rounded areas without pigment; under surfaces flesh-white without pigment; a very narrow line of chromatophores on dorsal surface of thigh.

Measurements in mm.: Snout to vent, 26; head length, 7.8; arm, 18; leg, 46.

Variation: The two paratypes taken at the same time and place differ negligibly, save that the tympanum is a little smaller and a little less distinct, and the tibiotarsal articulation reaches only to the tip of the snout. The measurement variations are given in the following table:

Measurements in mm. type and paratype of Cochranella colymbiphyllum (Taylor) *

No.	Total length	Head length	Head width	Arm	Hand and fingers	Leg	Foot and tarsus	Tibia	Femur
23812	26	7.8	9.5	18	8	43	20	15	13.7
790	25.8	8	9.2	18	8	43	18.8	13	12.8
791	25	7.4	9	16.5	7.7	44	19	13.8	13.5

There is a vague possibility that *C. colymbiphyllum* is identical with Boulenger's *Hylella puncticrus* that has been synonymized with *Centrolene prosoblepon* by Nieden (1923).

Remarks: Cochranella albomaculata differs from this form in having the snout less protruding, the hand more than half webbed, the feet four-fifths webbed, the vomerine teeth present, and the nostril closer to the eye. The dorsal color is lavender dotted with numerous cream spots. The eyelid is purplish black.

Cochranella granulosa differs in having the dorsum strongly granular, the nostrils closer to the eye than middle edge of lip,

* This corrects an error in the original table of measurements. The numbers 23812 and 791 were originally interchanged inadvertently.

the snout sloping obliquely in front of the nostrils, the vomerine teeth present and the choanae much farther apart. The webbing on hand and foot is distinctly greater.

Cochranella valerioi differs in having a very small tympanum the interorbital space twice width of an eyelid and the nostrils slightly anterior to lip.

C. fleischmanni differs in having the eyelid golden, the under surface of the thigh very strongly areolate on the entire under surface, a distinct outer metatarsal tubercle present, choanae farther apart, and the frontal area not concave. Both species have the vomerine teeth absent and the degree of webbing about the same.

The presence of vomerine teeth, numerous white punctations below the eye and the granulation of the underside of the thigh distinguishes *C. pulverata.*

The specimens were collected at night from leaves of plants growing in a small mountain stream. They appeared to be very wary and numerous individuals dived into the water and escaped. In the same identical habitat a series of *Centrolene prosoblepon* were taken. These were apparently less wary and more easily captured.

Cochranella pulverata (Peters)

Hyla pulverata Peters, Monatsb. Akad. Wiss. Berlin, 1873, p. 614 (type locality "Chiriquí" H. Ribbe, coll.); Brocchi, Étude des Batracien de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 1, 1881, p. 41; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed., 1882, p. 386; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 280.

Centrolene pulveratum Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 1931, pp. 393, 399 (*part.*) (Turrialba and Bebedero, Costa Rica); *ibid.*, vol. 8, June 7, 1933, pp. 73-74.

Centrolenella pulveratum Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, April 20, 1949, p. 258.

Cochranella pulverata Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 35.

Diagnosis: A small species (24 mm.); vomerine teeth present; tympanum present, round, small, covered with pigmented skin; back smooth, belly and under thighs granular; first and second fingers equally long, both shorter than fourth; strong web between second and third, and third and fourth fingers; toes fully webbed. Small white punctations above, with minute pigment spots or chromatophores.

Description of species: (data from the type description.)—Vomerine teeth in two groups between the choanae, which are much larger than the small openings of the Eustachian tubes. Tongue scarcely emarginate behind. Snout, not longer than the eye, with a rounded canthus rostralis. Tympanum round, very small, and

covered over with pigmented skin. Back smooth, the belly and underside of thigh granular; first and second fingers apparently equally long, much shorter than the fourth; first finger entirely free; the web between the second and third fingers reaches almost to the terminal pads of the second and somewhat over the base of the first joint of the second; between the third and fourth from the terminal disc of the fourth to the middle of the penultimate phalanx of the third. The toes are bound with a complete web which leaves only the two outer joints of the fourth toe free.

Color: Colorless, with scattered small white punctations which are numerous on the side of the head. Under a lens the surface is seen to be punctate with dark flecks.

Measurements in mm.: Total length, 24; head, 9; head width, 8; arm, 15; hand, with third finger, 8; leg, 45; foot and fourth toe, 20.

Remarks: One specimen, the type, is known from Chiriquí, Panamá. The species has been reported by Dunn from Bebedero and Turrialba, Costa Rica. The material not being available, I have not been able to confirm these identifications.

Cochranella granulosa (Taylor)

Figure 37

Centrolenella granulosa Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 265-267 (type locality Los Diamantes, 1 mile south of Guápiles, Costa Rica. R. C. Taylor coll.).
Cochranella granulosa Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 34.

Diagnosis: A rather large species of the genus (28 mm.) with strongly granular skin on head, back and sides of body, dorsal part of limbs, venter and undersurface of thighs. Toes ¾ to ⅘ webbed; vomerine teeth present; no projecting rudiment of a pollex; tibiotarsal articulation to 2 mm. beyond tip of snout; nostrils equidistant from eye and median tip of snout; eyelid purple, body (alcohol) creamy white with numerous scattered purple or lavender spots. Tympanum present; first finger equal to second in length.

Description of type: Head broader than body, the eyes strongly protruding, directed somewhat forward, the pupil horizontal; canthus rostralis distinct, slightly rounded; area about nostrils somewhat elevated with a slight depression between them; in front of nostril, snout slopes forward and down obliquely to edge of lip; loreal region sloping more gradually to lip; interorbital distance about one to one and one-half times width of eyelid; tympanum present, its diameter practically three times in longitudinal diameter of eye; a supratympanic fold from eye to near insertion of arm.

Tongue cordiform, slightly notched behind; opening to vocal sacs

curved slits reaching from level of middle of tongue to considerable distance behind tongue; choanae large, circular, the diameter of one contained in distance between them four times; two very indistinct vomerine ridges between choanae, each bearing two or three vomerine teeth.

Fingers short and broad, the tips dilated, that of fourth finger one half diameter of eye; a mere trace of web between first and second fingers; about one-fourth to one-fifth webbed between second and third but a rather distinct fringe reaches to terminal pad on outer

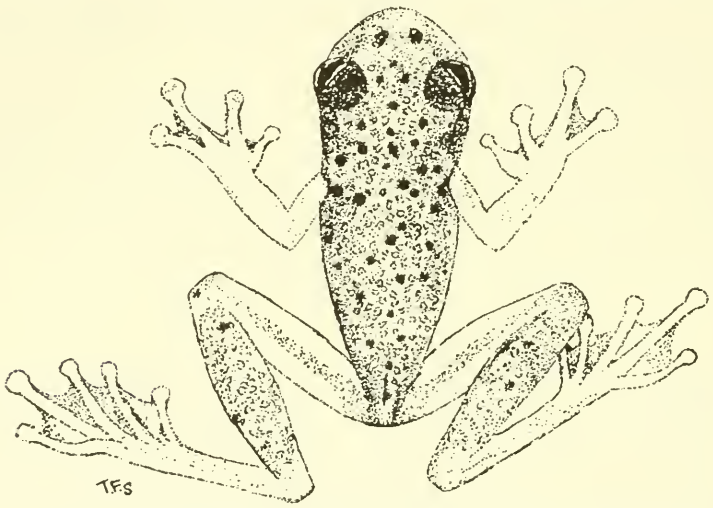

FIG. 37. *Cochranella granulosa* (Taylor). Type. Richard C. Taylor, no. 2463; Los Diamantes, Costa Rica. Actual snout-to-vent length, 28.2 mm.

side of the second; between third and fourth a little more than two-thirds webbed, a fringe reaching terminal pad on outer side of third finger; subarticular tubercles well defined; a large, very distinct oval palmar tubercle; large tubercle at base of first finger bearing colorless nuptial asperities, which extend much beyond tubercle and across the dorsal surface; a strongly defined fold on underside of forearm.

Legs long, the heels overlapping little more than two millimeters; tibiotarsal articulation extends beyond tip of snout about two or three millimeters; toes three-fourths to four-fifths webbed; subarticular tubercles distinct, rather large; a strong inner metatarsal tubercle; and a very small outer; a very slight, scarcely distinguishable inner tarsal fold.

Granulations on skin strongly defined on back, sides, head, and to a lesser extent on surface of forearm and lower part of leg and foot; on throat and chin, skin rugose but apparently not granular; venter and the greater part of underside of thigh, strongly areolar or granular, the granules being very much larger than those on back; those under the thigh distinctly larger than those on venter; a narrow, but relatively long transverse free flap covers anal opening. Large vocal sac, its surface somewhat rugose; nuptial asperities on thumb.

Color: In life, leaf-green with some slightly darker areas evident; below transparent white or flesh; in preservative (formalin transferred to alcohol) color cream-flesh with a very faint wash of lavender and with numerous (about 40) small purple spots; under a lens the lavender wash is seen to be caused by very numerous, small chromatophores. All ventral surfaces, and much of the lateral surfaces of limbs and body, cream-white, lacking pigment; eyelids purple; eyes silver with some purplish reticulation.

Measurements in mm.: Snout to vent, 28.2; width of head, 10; axilla to groin, 16; arm, 18; leg, 49.

Variation: The paratype is somewhat more lavender than the type. The dorsal spots are smaller and more numerous on the back and on the tibia. The iris of the eye is darker; the vomerine tooth patches are more distinct. Otherwise the two agree in all essential details.

Remarks: The absence of a humeral hook or process places this species in the genus *Cochranella* Taylor. Noble regarded the absence of vomerine teeth a character of the genus *Centrolenella.* However the teeth are not invariably present. The teeth may be absent in some individuals of a species and present in others.

The position of the nostril, halfway between eye and the median tip of snout, the purple eyelid, the very granular skin, the longer leg, presence of a tympanum, absence of a pollex rudiment, and the markings, will together distinguish this form from other species of *Cochranella.*

The specimens were taken at night during a rain on small trees growing on the edge of a small river.

Cochranella albomaculata (Taylor)

Figure 38

Centrolenella albomaculata Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949 (type locality Los Diamantes, one mile south of Guápiles, Costa Rica. E. H. Taylor and R. C. Taylor colls.).

Cochranella albomaculata Taylor, Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, p. 35.

Diagnosis: A rather large-sized species of the genus (27 mm. snout-to-vent); tympanum distinct, nostrils slightly closer to eye than to median point of snout at tip; interorbital distance equal to width of eyelid; heels overlapping; tibiotarsal articulation 4-5 mm. beyond tip of snout; toes five-sixths webbed, the membrane touching the terminal expansions on one side or other of all toes, save fourth; a distinct web present at base of first and second fingers; posterior part of back slightly but indistinctly granular; vomerine teeth strongly developed in two ridges near posterior level of

FIG. 38. *Cochranella albomaculata* (Taylor). Type K.U.M. N.H. No. 23814; Los Diamantes, Costa Rica; actual snout-to-vent length, 26 mm.

choanae. No pollex rudiment; purplish lavender with numerous cream spots on all unconcealed dorsal surfaces; first finger longer than second.

Description of type: Head a little wider than body, the eyes large, protruding, their diameter equal to their distance from tip of snout; areas about nostrils strongly swollen, with a depression between and somewhat behind them; canthus rostralis wanting; in front of nostrils the snout slopes to the edge of lip at an angle distinctly greater than slope of loreal region; lores distinctly concave; tympanum small, its greatest diameter contained in distance from

eye one and three-fourths times, and in the longitudinal diameter of eye a little more than three times.

Tongue rather rounded, not or but very slightly emarginate posteriorly, free for about one fifth its length; openings of vocal sacs elongate, curved slits, lying partly at side of tongue and extending some distance behind; choanae large, their diameter contained in space between, about three times; vomerine teeth in two raised patches lying between the posterior level of choanae and extending somewhat behind this level; (in paratype not reaching posterior level of choanae).

Digits short, widened at the tips, that of third finger a little more than one half diameter of eye; a very narrow web between first two fingers; second and third fingers one-third webbed, the web extending as a fringe to the terminal expansion on outer side of second finger; third and fourth toes two-thirds webbed, the web extending beyond level of subarticular tubercles; latter strongly developed; an elongate pad at base of first finger and very distinct palmar pad at base of wrist; base of first finger with an area of nuptial asperities; supernumerary tubercles indistinct; upper arm slender, forearm thickened with a well-developed fold on under side; legs long and slender, the tibiotarsal articulation extending several millimeters beyond tip of snout; when leg is adpressed to body heels overlap 2.2 mm.; toes four-fifths webbed, the web reaching the terminal pad of each toe on one side, except fourth; terminal pads truncate, that of inner toe rather pointed; a rather large inner metatarsal tubercle, rounded anteriorly, the tip slightly free; outer, if present, very indistinct; subarticular tubercles well developed; some distinct supernumerary tubercles; inner tarsal fold scarcely indicated.

Skin with some indistinct granulation on posterior part of back; slightly rugose anteriorly and on sides of body; upper surface of limbs also slightly rugose; throat and breast smooth; abdomen granular as is the greater part of under side of thigh; an enlarged granule on each thigh medially; segmentation of abdominal muscles distinctly indicated on venter; a small free flap over anal opening.

Color in life: Yellow-green on all exposed surfaces, with indications of small cream dots; all concealed surfaces creamy white, nearly transparent; in preservative (formalin transferred to alcohol) purplish to dark lavender above, somewhat lighter on the upper surface of limbs with numerous rounded cream spots or punctations, somewhat larger on hind limb than on back; venter and under

surface of limbs cream white; eyelids dark purple with white flecks; iris purple with minute silver flecks; some white flecks in tympanic and anal regions.

Measurements in mm.: Snout to vent, 26; width of head, 9; arm, 19; length of hind limb, 50; axilla to groin, 14.

Variation: The single paratype collected in the same locality with the type agrees in all essential details save that the vomerine teeth are somewhat farther forward; and an outer metatarsal tubercle is indicated. The color has been somewhat changed due to rust in the preserving fluid.

FAMILY HYLIDAE Günther

Hylidae Günther, Catalogue of the Batrachia Salientia in the collection of the British Museum, 1858 (1859), p. 96.

For the most part, the widely distributed family of the Hylidae comprises frogs adapted to arboreal habitats, although certain genera may contain species that are wholly terrestrial in habit. Most of the hylid species have the terminal parts of their digits widened, the underside of which bears an adhesive pad or disc that enables the animal to cling to smooth surfaces in a vertical or even in an inverted position. In some forms the inner finger may be partly or wholly opposed to the other digits. In a few forms the skin on the head is co-ossified with the skull and a casquelike cranium may be developed.

Eggs of the hylidae may be deposited in fresh water, on the ground, on leaves above the water, in arboreal bromelias—plants that accumulate water in the leaf axils—or they may be carried about by a parent in a dorsal brood-pouch.

The six hylid genera here recognized in Costa Rica are: *Anotheca, Smilisca, Acrodytes, Phyllomedusa, Agalychnis* and *Hyla*—the latter composite. The species here treated as *Hyla albomarginata* probably does not belong in the genus *Hyla* in a restricted sense, since it has a well-developed pollical spine present in males; and the group including *Hyla fimbrimembra, Hyla richardi* and *Hyla immensa* are probably not generically identical with *Hyla.* Just what the generic relationship is, in these forms, cannot be decided at the present because of lack of necessary skeletal material from South and Central America.

The genus *Hyla* is the largest amphibian genus, in point of species, in the Costa Rican fauna. It is significant, that in one Central American group of the genus, five species have been described from single specimens and to date, presumably, no others have been

found. In other groups of the genus *Hyla* one or more species are likewise known from one or at most very few specimens.

In collections made in 1947 by Richard C. Taylor and myself were six presumably undescribed species; in the 1951 collection there are at least four others regarded as new. Of the six new species taken in 1947 only one was represented in the collection taken in 1951.

It is difficult to account for the fact that of the Hylidae alone ten endemic species are known in Costa Rica from single specimens; while several others are known from single collections of from two to five specimens each. When the entire salientian fauna is considered, this number of unique types is greatly increased. Because of the general inaccessibility of the forms adapted to arboreal conditions, *Hyla* probably has the greatest number of undiscovered species. Several arboreal frog voices, quite unknown to me, were heard in various parts of the country, suggesting species that still await discovery. These facts and others bespeak a very inadequate survey of the salientian faunas of Costa Rica and the remaining Central American territory; and much more collecting must be done before an adequate treatise on the Central American Salientia can be written.

Since the 1947 and 1951 collections were made from the middle of June to the middle of September, sampling of the faunas during other months of the year is essential to our knowledge. This present work on the hylids must of necessity be considered of a preliminary nature.

KEY TO COSTA RICAN GENERA OF THE FAMILY HYLIDAE

1. Adults with a series of sharp spines bordering edges of bones in interorbital and occipital region of skull ..... *Anotheca*
   Adults lacking series of spines on head bones 2
2. Skull with an elongate bony process or spine from frontals, extending somewhat behind orbit, not visible externally; a pair of vocal sacs on sides of chin in males ..... *Smilisca* °
   Skulls lacking such a process 3
3. A pair of vocal sacs in males extending out on sides of head behind jaw angle. A parotoid gland (often diffuse) on occiput and dorsum ..... *Acrodytes*
   Vocal sac when present single and confined to chin 4
4. Pupils of eyes horizontal ..... *Hyla*
   Pupils of eyes vertical 5
5. Feet with an ample web; vomerine teeth present ..... *Agalychnis*
   Feet without webbing; vomerine teeth absent ..... *Phyllomedusa*

° The presence of the bony process can be determined by superficial dissection.

The following North- and Central American genera are recognized in the Family Hylidae.

Hyla	*Diaglena*
Acris	*Triprion*
Pseudacris	*Corythomantis*
Acrodytes	*Pternohyla*
Smilisca	*Plectrohyla*
Anotheca	*?Nyctimantis*
Nototrema	*Ptychohyla*
Agalychnis	*Hylella*
Phyllomedusa	

Miranda-Ribeiro* has recognized several other genera in South America including:

Güntheria	*Fritzia*
Trachycephalus	*Coelonatus*
Garbeana	*Flectonotus*
Aparasphenodon	*Gastrotheca*
Hylomantis	*Opisthodelphis*
Bradymedusa	

Not having studied this material, I have no first-hand knowledge of the merit of these genera but suspect that many of them, possibly all, merit generic distinction. I doubt that representatives of these occur in Costa Rica. It is likewise probable that certain other generic names proposed by older authors, merit resurrection from synonymy.

Genus SMILISCA Cope

Type of genus: *Hyla baudinii* Duméril and Bibron.

Frogs of this genus are distinguished by paired vocal sacs and a postorbital spine on skull. A single widespread species is recognized.

Smilisca baudinii (Duméril and Bibron)

Hyla baudinii Duméril and Bibron, Erpétologie Générale, vol. 8, 1841, pp. 564-565 (type locality Córdoba, Veracruz—restricted); Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, pp. 241-242 (localities in Nicaragua); Schmidt, Zool. Ser. Field Mus. Nat. Hist., vol. 22, no. 8 (publ. 512), Dec. 30, 1941, p. 486 (localities in British Honduras); Schmidt and Stuart, *ibid.*, vol. 24, no. 21, Aug. 30, 1941, p. 238 (San Gerónimo, Guatemala).
Smilisca baudinii Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 17, 1865, p. 194.

The species is included on the basis of two Costa Rican specimens from Nicoya, Guanacaste.

* Miranda-Ribeiro, Notos Para Servirem as Estudo dos Gymnobatrachios (Anura) Brasileiros. Arch. Mus. Nac. Rio de Janeiro, vol. 27, 1926, pp. 63-114.

Diagnosis: Rather large hylid frogs, characterized by a pair of sharp pronglike processes on the sides of the frontoparietal bone; males with paired ventral vocal sacs; diameter of tympanum approximately three fourths of eye length; digital discs smaller than tympanum; a tarsal fold present; inner metatarsal tubercle compressed elevated.

Description of species: (From a specimen from Apatzingan, Michoacán, Mexico.) Head in preserved specimens tending to bend down at something less than a right angle to the body; the interorbital region slightly concave; area about nostrils slightly swollen without a depression between; snout rounding in profile, extending slightly beyond mouth; canthus distinct curving forward; lores concave and sloping obliquely to lip; tympanum overhung by a fold from eye that curves down a short distance, then continues back an indefinite distance above arm as a loose skinfold; diameter of tympanum (4.6 mm. in greatest diameter) about four fifths of eye length (5.7 mm.); distance between tympanum and eye less than half diameter of tympanum; length of eye a little less than axial length of snout (6.1 mm.); vomerine fasciculi high, closely approximated, transverse, the tooth rows between middle of choanae; separated from large choanae by a little more than length of one fasciculus; palatal glands opening in sinuous groove, nearer anterior end of palate than to choanae; tongue subcircular to broadly cordiform, with a suggestion of posterior emargination; males with vocal slits, and paired sacs visible on underside of chin and throat; a breast fold indicated; openings of Eustachian tubes smaller than choanae.

Arm rather long, the digits with discs much smaller than tympanum; inner finger somewhat opposed to other fingers, shorter than second, the two with only a slight lateral ridge representing web remnant; outer fingers one-fifth to one-fourth webbed with slight fringes to discs; a large inner metacarpal tubercle; palmar tubercle rather large, bi- or tripartite; palm granular with some supernumerary tubercles; subarticular tubercle single except one on outer finger that may be slightly bifid; a ridge or series of tubercles on outer edge of forearm.

Leg moderately long, the heel reaching to front edge of eye; inner metatarsal tubercle large, compressed with a narrow, free, protruding edge; outer tubercle very dimunitive; toes three-fourths webbed; a strongly compressed tarsal fold.

Skin generally smooth but under a lens minutely corrugated and

pustulate, the pustules slightly larger on sides of dorsum; chin and breast granular, the granules not as distinct or so closely approximated as on venter and median part of ventral surface of thighs.

Vent opening at upper level of thighs followed by a distinct groove bordered by two narrow vertical folds or slight ridges; an indefinite ridge between nostril and eye across loreal region.

Color: (in preservative.) Dark blackish brown above, almost obscuring some large irregular blackish spots; a distinct bar across eye and a dark spot below eye; lip with a very narrow cream border; tympanum lavender brown; a dark spot or stripe from tympanum to above arm not too well defined; sides grayish with some light marks in groin; chin and breast white, venter and under part of limbs flesh white; limbs dimly barred with gray reticulation on back of thigh.

Measurements in mm.: Snout to vent, 62; width of head, 22; length of head, 18; diameter of tympanum, 4.6; length of eye, 5.7; length of snout, 6.1; arm, 35; hand, 16; leg, 85; tibia, 30; foot and tarsus, 41.

Variation: Specimens vary considerably in color. During the breeding season the two sexes may be deep leaf-green to olive green above, with a light orange or creamy yellow venter; there are spots in the groin that are cream or light orange yellow.

Specimens taken at other times are more rarely green but are darker, usually a shade of brown with black spots or markings on back, and dark cross-bands on limbs. There is almost invariably a dark stripe crossing the tympanum, extending back above arm insertion. The tympanum is usually uniform brown or lavender-brown.

Remarks: The voice of the males is a loud "quack, quack" and in the breeding season they develop deafening choruses. They are frequently heard at other times where a group of males are congregated in trees especially on rainy or misty evenings.

This species has been confused with two other Costa Rican species: *Hyla phaeota* and *Hyla gabbii.* Both of these are differentiated by the absence of the spines on the frontoparietal and the males have a single vocal sac. *Hyla gabbii* presumably never has the black temporal stripe behind tympanum; but it is present in *Hyla phaeota.* This latter species is larger, with longer hind legs reaching at least to the tip of the snout or farther. Females of the three species are sometimes more difficult to separate and on occasion I have had to resort to a dissection (cutting skin on head

to determine the presence or absence of spines on the fronto-parietal*) in order to be sure.

Genus ANOTHECA Smith

Type of genus: *Gastrotheca coronata* Stejneger.

The adults of this species may readily be identified by the thorny spines around the back of the head in both males and females. These are not evident in young specimens.

The type of this species was collected at Palomo, Valle de Orosi, Cartago, Costa Rica. The species has not been rediscovered in Costa Rica, and is still known only from the type, unless a small specimen taken by C. E. Underwood in Costa Rica before 1900, and reported by Günther as *Nototrema oviferum* Lichtenstein and Weinland, is indeed this species. The species has been taken in numbers in Veracruz. That the range is continuous from Veracruz to Costa Rica may be questioned, since in the very numerous collections made during the past forty years in northern Central America and Southern Mexico no specimen of this conspicuous form has appeared.

Anotheca coronata (Stejneger)

Figure 39

? *Opisthodelphys ovifera* Günther, Catalogue of the Batrachia Salientia in the collection of the British Museum 1858 (1859), p. 117 (Córdoba, Veracruz, Mexico) (*nec Notodelphys ovifera* Lichtenstein and Weinland).

Nototrema oviferum (*part.*) ? Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, p. 288, pl. 74, fig. a (Carillo, Costa Rica) (*nec ovifera* Lichtenstein and Weinland); Nieden, Das Tierreich, Lief. 46, Anura I, June, 1923, p. 324.

Gastrotheca coronata Stejneger, Proc. U. S. Nat. Mus., vol. 41, Aug. 14, 1911, pp. 287-288 (type locality, Paloma, Valle de Orosi, Cartago, Costa Rica, 1200 M. elev. C. Picado, coll. U.S.N.M. No. 48270); Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 131, 133-135; Picado, Bull. Sci. France Belg., ser. 7, vol. 5, 1913, pl. —, fig.; Dunn, Copeia No. 3, Nov. 19, 1937, p. 164. "The type . . . still the only Central American specimen of the genus."

Anotheca coronata Smith, Proc. Biol. Soc. Washington, vol. 52, 1939, pp. 190-191, pl. 1, figs. 1-3, pl. 2, fig. 6; Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, pp. 601-602, figs. 60 B-C (Mexican localities Cuautlapan, Córdoba and San Juan de Gracia).

Diagnosis: Much of the skin on top of head grown solidly to underlying bone in adults; outline of the parietal region somewhat concave, the edge of the skull with a bordering row of high, conical, erect, bony spines, only the tips of which are visible or they may be entirely covered by the thickened glandular skin; spines present also above tympanum, and a supraorbital series also present; tympanum circular nearly as large as eye; fingers free; toes one-third webbed.

* Cope. Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, pt. 1, July, 1866, pp. 85-86, pl. 25, gives a figure showing skull characters of this species.

FIG. 39. *Anotheca coronata* (Stejneger). K.U.M.N.H. No. 27365; 13 km. WNW Potrero, Veracruz, Mexico, 1700 ft.; actual snout-to-vent length, 46 mm.

Description of the species: Head nearly as wide as long, the skin tending to form pustular glandules about the spines; elsewhere skin tending to fuse with the bone; canthus rostralis somewhat elevated with granules representing small concealed spines; snout rounded, slightly longer than the length of the orbit; top of head and loreal region concave; eyelid much narrower than interorbital space; tympanum circular, its diameter about four fifths of the length of orbit; nostrils closer to median edge of upper lip than eye; width of an eyelid 2.45 mm., interorbital width 5 mm.

Tongue subcircular, slightly emarginate behind, less than one-sixth free behind; choanae large; vomerine teeth in two closely approximated, elevated fascicles between choanae but reaching behind their hinder level; palatal glands open into a transverse sinuous groove on palate anterior to choanae; maxillary teeth in specimen 45 mm., in length 35-37; premaxillary teeth 9-9; arm moderately long without an axillary web; fingers somewhat flattened without web but with small lateral ridges on fringes; subarticular tubercles large, those on outer fingers double as is that under second finger; prominent elevated supernumerary tubercles on palms; a large meta-

carpal tubercle at base of first finger and a tripartite outer palmar tubercle (these may be distinct or in contact); a few indistinct tubercles under arm; leg of medium length the heel reaching midway between eye and nostril; toes about a third webbed; however, that between two inner toes vestigial (one fifth), on outer toes one third to two fifths. The fifth toe reaches beyond distal tubercle of the fourth toe; a distinct tarsal fold present; discs on fingers, the largest equal to three fifths of the tympanum; skin smooth to partly granular above; the bony surface of skull very rough, granular; chin and breast smooth; belly closely and finely granular; median half of underside of femora granular; anal opening low with a long flap, the opening almost on a level with the ventral surface of body.

Measurements in mm. of type: Snout to vent, 60; snout tip to tympanum, 21; tip of snout to posterior edge of "casque" on median line, 18; width of head, 22; arm and foot (from axilla), 41; hind leg from vent, 93; tibia, 31.

Color: In alcohol, dark bluish slate; on sides and in groin several large, vertical, dark spots narrowly edged with whitish; hind limbs with transverse bands of dark color similarly edged with whitish; below paler.

Variation: Mexican specimens are often gray or lavender gray above. The side of head is purplish with a large gray spot on lores. The femora have purplish spots on the posterior and anterior faces that may meet on the dorsal surface; the underside of the tibia and tarsus has intense purplish black spots outlined in whitish cream; the chin and throat are usually brown, the venter purple. There are two areas on the breast outlined in white.

This species, in Costa Rica, is known only from the type specimen and perhaps one other specimen. Dr. Hobart M. Smith found the species to be common under the drying petioles of standing banana plants in central southern Veracruz at certain seasons. The figure given is of a specimen from 13 kilometers west-northwest of Potrero, Veracruz, Mexico.

Genus ACRODYTES Fitzinger

Types of genus: *Phrynohyas* (*Acrodytes*) *venulosa* = ? *Rana venulosa* Laurenti.

There is some uncertainty as to the proper (oldest) generic name available for this group. *Phrynohyas* may have to take precedence. Cope* however refused *Phrynohyas* in favor of *Acrodytes*. I cannot decide the matter at this time.

* Cope, Natural History Review, 1865, p. 109.

Only a single species of the genus is known to occur in Costa Rica and it is not wholly certain that it is conspecific with *Rana venulosa* of Laurenti as I have treated it here.

Acrodytes venulosa (Laurenti)

Rana venulosa Laurenti, Specimen medicum, exhibens synopsin reptilium emendatum cum experimentis . . ., 1768, p. 31 (*part.*).
Phrynohyas (*Acrodytes*) *venulosa* Fitzinger, Systema reptilium, vol. 1, 1843, p. 30.
Acrodytes venulosa Taylor, Univ. Kansas Sci. Bull., vol. 30, pl. 1, May 15, 1944, p. 64.

Until the South and Central American forms of this genus are reviewed the reference of the Costa Rican form of *Acrodytes* to this species is a matter of guess.

Diagnosis: Large tree frogs; skin thick, leathery, strongly glandular; a pair of lateral vocal sacs in the males usually to be found just above the arm; hind legs short, the heel reaching to tympanum; toes four-fifths webbed; a small web remnant between the fingers; no trace of a tarsal fold present.

Description of species: (U.M.M.Z. No. 71211, Los Huecas, C. R.). Head thick, the width (27 mm.) greater than the length (23 mm.); length of the eye (6.5 mm.) equal to its distance from nostril; diameter of tympanum (5 mm.) less than eye length, separated from eye by a distance of 3 mm.; no canthus rostralis indicated; area about nostrils not swollen; loreal region sloping obliquely to lip; tip of snout sloping obliquely to near edge of lip, the tip extending 2 mm. beyond the edge of lip; width of an eyelid (6.8 mm.) about equal to interorbital distance; distance between nostrils 5 mm.; length of eye nearly equal to length of snout.

Vomerine teeth in two enlarged fasciculi situated between the choanae, almost contiguous mesially; choanae diagonally elongate, smaller than a single fasciculus, the teeth forming two irregular curving series; the palatal groove forming a sinuous line that reaches to very near the anterior edge of palate; vocal slits rather short; tongue about as broad as long, free behind for only about one sixth of its length; dorsum with a single broad "parotoid" varying in thickness from 1.2 mm. to .5 mm. Scattered over this area are some larger glandules that appear on the surface as scattered granulations but appear smooth and rounded on the skin surface; thin black vocal sacs appear in a fold above arm insertion; the supratympanic fold not distinguishable from the edge of the parotoid area, that tends to overhang the tympanum.

Arm short, thick, the wrist reaching at least to tip of snout; discs on fingers enlarged, the largest equaling the tympanum in extent; a strong web remnant between three outer fingers, of lesser extent between the two inner; first finger somewhat opposed to other three, the web forming a slight fringe or ridge to the pads on all digits; distal subarticular tubercles all well developed, that of outer finger bifid; inner metacarpal tubercle elongate oval; outer and medial tubercles small, scarcely indicated; leg moderate, the heel reaching tympanum; tarsus smooth without fold, but with a faint raised area along outer edge; inner metatarsal tubercle oval, small, 3.5 mm. long, less than half length of first toe (8.5 mm.); toes four-fifths webbed, the web reaching discs on outer side of first, second and third, and inner side of fifth; a fringe or ridge reaching discs elsewhere; subarticular tubercles strong; supernumerary tubercles scarcely indicated; outer metatarsal tubercle flat, scarcely discernible; limbs and arms smooth as is back, save for a few scattered, smooth, granulelike elevations; chin, breast, venter, much of ventral and posterior part of thighs, granular.

Color: Purplish above with indication of fine lighter lines, the lines tending to break up the dark area into asymmetrical, elongate stripes; a dorsolateral light lavender stripe from eyelid back to middle, that widens and turns down towards venter. A purplish area surrounding tympanum extends back above arm; a yellow area about arm insertion; legs and arms barred with purple, the spots light-edged; venter nearly uniform yellow-cream.

Measurements in mm.: Snout to vent, 77; head width, 27; head length, 23; length of eye, 6.5; eye to nostril, 6.53; diameter of tympanum, 5; snout length, 6.8; arm, 38; hand, 21; leg, 96; tibia, 33.5; foot and tarsus, 48.

Remarks: We did not find this form in Costa Rica, and I have used a University of Michigan specimen from Los Huecas, C. R., for the description.

Genus AGALYCHNIS Cope

Type of genus: *Hyla moreletii* A. Duméril.

These frogs are strictly arboreal in habit. Certain of the species of the genus lay their eggs above the water on the leaves of plants or on the edge of a pool. The color in life is usually green above and saffron or orange below. Three species are recognized in Costa Rica.

These may be identified by the following key:

KEY TO COSTA RICAN SPECIES OF AGALYCHNIS

1. A series of diagonal cream lines on side of body, eye red; smaller, less than 60 mm. 2
   No diagonal cream lines on sides of body, larger, 75 mm. ..... *moreletii*
2. A dark purplish lateral band bordered above by cream and interrupted by at least five narrow vertical cream or yellow bands; 32 mm. ♂ ..... *helenae*
   Dark lateral band not bordered by a cream line but broken by several vertical bands; under surfaces saffron; 34.5 mm. ♂, 45 mm. ♀ ..... *callidryas*

Agalychnis moreletii (A. Duméril)

Figure 40

Hyla moreletii A. Duméril, Ann. Sci. Nat. Paris, ser. 3, Zool., vol. 19, 1853, p. 169 (type locality, Cobán, Verapaz, Guatemala); Keferstein, Nachr. königl. Ges. Wiss. Göttingen, 1867, pp. 256, 257; and Arch. für Naturg., 34th Jahrg. Heft. 1, 1868, p. 297 (Costa Rica); Brocchi, Bull. Soc. Philom. ser. 7, vol. 1, p. 122; Mission Scientifique au Mexique (etc.); Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 31, pl. 13, fig. 1.

Agalychnis moreletii Cope, Nat. Hist. Rev., 1860, p. 110; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 107 (San José, Costa Rica); Boulenger, Catalogue of the Batrachia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, pp. 422-423; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 15; Werner, Abh. Akad. Wiss., Bd. 22, Abt. 2, 1903, pp. 351-352 (Coban, Guatemala); Verh. zool.-bot. Ges. Wien, 1896 (p. 9 in separate), (Honduras); Gaige, Carnegie Inst. Washington Publ. no. 457, 1936, p. 293 (Campeche); Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, pp. 599-601, pl. 31; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, pp. 71-72.

Phyllomedusa moreletii Kellogg, U. S. Nat. Mus. Bull., no. 160, 1932, pp. 142, 143, 146-147, figs. 19a, 20a, b (hand and foot); (Mexico and Guatemala).

Hyla holochlora Salvin, Proc. Zool. Soc. London, 1860 (1861), pp. 460-461, pl. 32, fig. 2 (Coban, Guatemala).

Diagnosis: A large frog, brilliant green and orange or green and cream in life, which may become bluish (or perhaps more often lavender or purplish) and flesh white in preservative; upper arm extremely thin with a much thickened forearm; pupil vertical; finger discs large, with fingers more than half webbed; tongue about half free; vent opens on a level with lower surface of thigh.

Description of species: (From K.U.M.N.H. No. 29549, Cartago, Costa Rica.) Rather large, the snout-to-vent length reaching 55 mm. in males, 75 mm. in females; width of head (17.7 mm.) very slightly less than length (18 mm.); canthus distinct, rounded; area above nostrils very little swollen without distinct depression; from nostrils snout slopes obliquely forward to lip; loreal region slightly concave, the upper part nearly vertical, the lower sloping obliquely to lip; supratympanic fold diagonal, overhanging and covering upper part of tympanum; latter very distinct, subcircular, its length 3.2 mm., separated from eye by distance equal to half its diameter;

eye prominent, its length (5.3 mm.) greater than its distance from nostril (5. mm.) but shorter than length of snout (8 mm.); nostril minutely nearer the median notch in upper lip than eye; width of an eyelid (4.6 mm.) much less than interorbital width (7 mm.); choanae rather large, irregular, the distance between them 5.2 mm.; diameter of a choana in this distance 3.4 times; vomerine teeth in two small fasciculi between anterior part of choanae, separated from each other and from choanae by a distance equal to length

FIG. 40. *Agalychnis moreletii* (A. Duméril). K.U.M.N.H. No. 29549; Cartago, Costa Rica; actual snout-to-vent length, 54 mm.

of a fasciculus; tongue subcordiform, notched posteriorly and anteriorly, free behind for a third of its length; vocal slits rather short having a distinctly posterior position in mouth; openings of palatal glands in a sinuous row, not forming a groove, and nearer to the median anterior point of palate than to choanae.

Skin generally smooth, but under a lens is seen to be minutely corrugated or granular; supratympanic fold diagonal, overhanging slightly; a strong skin fold from elbow to disc of outer finger; a less well-developed one on leg from heel to disc of outer toe; venter strongly granular; breast slightly granular, the chin less so; granules

extending high on sides of body; anal flap elongate, the vent opening on a level with ventral surface of thigh; slight pads under outer part of the anal flap, its surface covered largely with strong granules; under surface of thigh covered with irregular granules.

Arm long, the anterior half of forearm reaches beyond snout; upper arm thin, less than half diameter of forearm; finger discs large, the three outer of nearly same size; first about half diameter of fourth; subarticular tubercles large, that on outer finger single but with a slight indentation; inner metacarpal tubercle large, its dorsal surface and that of base of first toe with nuptial swelling covered with minute horny asperities; between fingers one and two, one-third webbed, between two and three, web is two thirds length of second finger; between third and fourth, web reaches level of distal subarticular tubercles; palmar tubercle divided with median portion the larger; supernumerary tubercles present on palm.

Leg short, reaching anterior edge of eye; when legs are folded at right angles to body, heels barely touch; discs on toes smaller than those on fingers; between first and second toes one-third webbed; between others about two thirds webbed; inner tarsal fold thick, distinct, numerous distinct supernumerary tubercles on sole and toes.

Color: Above uniform green, on body, head and upper surface of unconcealed portions of limbs; venter and all concealed surfaces yellowish. In preservatives the dorsal color becomes purplish lavender, the yellow changing to flesh white; some whitish flecks about anal region (white spots rarely present on back).

Measurements in mm.: Snout to vent, 54; width of head, 17.7; length of head, 18; length of tympanum, 3.2; length of eye, 5.3; length of snout, 8; arm, 38; hand, 18; leg, 78; tibia, 27; foot and tarsus, 38.

Remarks: In a population occurring in the environs of Cartago, Costa Rica, I found some variation in males as to the length of fingers and the amount of webbing. None however approach the degree of webbing depicted in Nieden's figure, *loc. cit.*

The upper arm is entirely without the green coloration and the upper part of thigh has a narrow band of green usually the entire length of femur.

Specimens were taken on rainy or misty nights. Males were heard calling and their calls traced. Females are not represented.

It seems most probable that *Agalychnis holochlora* and *moreletii* are conspecific. I have no topotypic material from Coban, Guatemala, the type locality, available for comparison with the Costa Rican forms referred to *moreletii* here. When compared with a

Mexican specimen, the Cartago specimens have somewhat smaller pads and seemingly are smaller and a little more slender. However only a single Mexican specimen is at hand for comparison.

Agalychnis helenae Cope

Agalychnis helenae Cope, Proc. Amer. Philos. Soc., vol. 22, 1884 (1885), pp. 182-183 (type locality, Nicaragua, J. F. Moser, coll.); Proc. Amer. Philos. Soc., vol. 23, 1886, p. 274; Peracca, Boll. Mus. Torino, vol. 11, 1896, No. 253, p. 12; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 290 (Mexico, Teapa, Tabasco; Nicaragua, Hda. Rosa de Jericho, 3250 ft.; Costa Rica, San Carlos; Panamá, Darién, Río Sabaná); Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, pp. 343-344, pl. 16, fig. 2 (photograph of a specimen).

Diagnosis: A rather small member of the genus with a somewhat indistinct tympanum; fingers one-fourth webbed, toes one-third webbed; eye one third longer than snout; nostrils nearly terminal; a dark purplish lateral stripe broken by vertical yellow bars; eye red or orange-red.

Description of species: (Data from the type description.) Head large and wide, snout short; long diameter of eye a little less than length of snout in front of eye, measured obliquely; or one third longer than snout measured axially; length of eye in the width between anterior canthi of eyes, one and one-half times; nostril nearly terminal; canthus rostralis distinct, concave; tympanum a subvertical oval, not distinct, two thirds as long as the diameter of eye; lower eyelid with oblique subparallel white veins; vomerine teeth in short series directed inwards and backwards from anterior inner angle of choanae; tongue large, wide, openly emarginate behind; inner digits of hand not opposable, all digits bearing discs, the first and second shorter than adjoining digits; fingers one-fourth webbed, toes one-third webbed; heel reaches tip of snout. Skin smooth, heel and elbow with a dermal thickening at the apex; inside of elbow joint is slightly webbed.

Color: The color in alcohol is greenish cream. The same color covers the external faces of forearm, tibia, tarsus, fifth toe and a narrow band on upper face of femur. The humerus and concealed surfaces of limbs orange; a well-defined dark purplish band bordered above by a yellow line, extends from axilla to groin. The dark lateral stripe interrupted by five vertical narrow yellow bands which cross the purple lateral band and join the yellow border. Digits and lower surfaces yellowish; deeper yellow on abdomen.

Measurements in mm.: Snout to vent, 30; width of head, 11.5; arm, 10.8; leg, 42; foot and tarsus, 17.5.

Remarks: Cope (1886) reported a Nicaraguan specimen, larger

than the type, in which a yellow line borders the lateral purple stripe and the bars which cross it are wider. There are also traces of pale cross bands on the back. Noble, *loc. cit.*, describes the life coloration of a specimen from Colorado Bar, Costa Rica, which was kept alive for some time. Generally the ground tone was a dark slaty green or a bright leaf-green. A number of pale green spots would often appear, scattered irregularly over the back; sometimes they would form an H-shaped mark just anterior to the pectoral girdle; concealed portions of the legs, which appear purplish in alcohol, were a deep blue in life. The feet and hands were brilliant orange. The edge of the upper eyelid was a deep yellow in striking contrast to the orange-red iris. The ventral surface of the throat and body was yellowish white; anterior appendages slaty color, while the posterior limbs were a yellowish white washed entirely, except for a narrow strip, with the deep blue of the concealed portions. Noble states that it is called "la rana de los plátanos."

Description of K.U.M.N.H. No. 30412 ♂ : Snout-to-vent length, 32 mm.; head narrowed anteriorly; canthus distinct, very slightly rounded, curving slightly from eye to nostril; nostrils not terminal, the snout in front of nostrils slopes forward to tip; eyes prominent, blood-red in life, the pupil vertical (in preservation all trace of red lost and the pupil appears nearly round); tympanum more or less distinct, covered with skin, showing fine granulation; distance between tympanum and eye about one half diameter of tympanum (3 mm.); length of eye (7 mm.) slightly greater than length of snout (6.4 mm.); width of an eyelid (4.3 mm.) less than interorbital distance (5 mm.).

Tongue oval, deeply notched behind, free behind for more than a fourth of its length; vocal slits extending some distance behind tongue; choanae large, irregular, somewhat angular, their outer edges partially concealed by the palatal shelf; vomerine teeth in two fasciculi situated between choanae, and converging until they are separated by less than half length of one fasciculus, separated from choanae by a distance about that of a single fasciculus; opening of Eustachian tubes large but definitely smaller than choanae.

Arm elongate, the upper arm very slender, more than two thirds of the forearm reaching beyond tip of snout; discs on toes larger than tympanum; base of first finger with a small patch of dark nuptial excrescences, extending on the surface of the large inner metacarpal tubercle; a small web remnant between first and second fingers; that between second and third fingers equal to a little less than half length of second toe; web between two outer fingers

reaching half the length of outer finger; distal subarticular tubercles elevated, single, but outer ones may be indented on anterior edge; supernumerary tubercles present; a ridge or fold from wrist to and onto elbow; outer metacarpal tubercle if present not distinguishable from other tubercles.

Leg moderate, rather slender, the tibiotarsal articulation reaching about halfway between eye and nostril; terminal discs on toes small, scarcely wider than digits; webbing between first and second and between second and third, about half length of inner digits; two-thirds webbed between outer toes; a distinct inner metatarsal tubercle, no small outer tubercle; a tarsal fold moderately prominent, becoming higher near and on heel.

Skin smooth, seen under a lens very finely granular on dorsum; skin on sides finely striate or wrinkled; an indistinct fold above tympanum continues down to above arm insertion; chin smooth; venter and most of under surface of thighs with fine granules; anal flap carried to ventral level of thigh.

Color in life: Brilliant green above; sides of body with a broad blue stripe from axilla to groin, bordered above by a creamy yellow line, and segmented by rather narrow yellow lines; light parts of hands and feet orange; darker parts green; chin dirty white; venter cream; lavender to blue on back of thigh, upper front of tarsus, and tibia; a narrow green line on upper surface of thigh; upper part of arm bluish; eye blood- to orange-red with a black vertically oval pupil; a yellow border on posterior edge of eyelid; lines in lower eyelid grayish or silver.

In preservation the green becomes purple, the blue becomes lavender; the yellow or orange areas become white.

Measurements in mm.: Snout to vent, 32; width of head, 17.7; length of head, 18; length of eye, 7; length of snout, 6.4; arm, 34; leg, 81; tibia, 27.5; foot and tarsus, 34.

Remarks: Individuals were found at Bataan, Costa Rica, at night (July 22), in a tree close to edge of a small rain-pool. They were discovered by tracing their calls. A third specimen was seen but it escaped by leaping to higher branches in a forest tree.

Agalychnis callidryas (Cope)

Hyla callidryas Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 14, 1862, p. 359 footnote (type locality,* Panamá, Capt. Field, coll.).

Agalychnis callidryas Cope, Nat. Hist. Rev., 1865, p. 110; U. S. Nat. Mus. Bull. 32, 1887, p. 15 (near Córdoba, Veracruz; Panamá); Barbour, Bull. Comp. Zool. Harvard Coll., vol. 69, 1929, p. 145 (Corn Islands off mainland

* Smith and Taylor, (Univ. Kansas Sci. Bull., vol. 33, pt. 2, 1950, p. 347) inadvertently give Córdoba, Veracruz as the type locality. This should be Panamá.

of Nicaragua; San Pablo, República de Panamá); Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, p. 414 (Barro Colorado Island, Canal Zone); Gaige, Carnegie Inst. Washington, Publ., No. 457, 1936, p. 292; Schmidt, Zool. Ser. Field Mus. Nat. Hist., vol. 22, 1941, p. 487 (Valentin, British Honduras); Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, p. 72 (Mexican localities); Stuart. Misc. Publ. Mus. Zool. Univ. Michigan, No. 69, June 12, 1948, p. 35 (Alta Verapaz, Guatemala).

Phyllomedusa helenae Kellogg (*nec* Cope), U. S. Nat. Mus. Bull. 160, 1932, pp. 142, 145 (Mexican localities).

Diagnosis: In life, green with vertical pupil, the eye red; outer fingers one-fourth webbed; moderately large discs on fingers and toes; inner toes with a web remnant; three outer toes slightly less than one-half, to one-half webbed; straight rounded canthus rostralis; eyes moderate, shorter than snout; vomerine fasciculi arising near the inner pointed portion of large choanae, which are partially concealed when seen from below by elevated anterior border.

Description of species: (From the type description.) Head elongate, maxillary outlines convergent, nearly straight; loreal region subvertical. Canthus rostralis straight, rounded. Eyes not large, transparent portion of inferior palpebra reticulated with white; iris cupreous. Tympanum nearly as large as eye, obliquely elliptic. Tongue elongate elliptic, openly emarginate. Inner nares large, widely separate; vomerine teeth between these, in two oblique series convergent posteriorly, anteriorly opposite anterior border of nares. Fingers one-fourth webbed; discs very large; toes one-half webbed, margined; skin smooth above.

Color: Blue purple above, greenish on the scapular region; humerus, femur, except a narrow blue stripe, and under surfaces, uniform saffron. Numerous oblique bands of a lighter yellow on sides.

Measurements in mm.: Snout to vent, 34.5; snout to angle of mouth, 14.8.

Remarks: I have examined no specimen from southern Central America. It is included in the faunal list because the range presumably includes localities both north and south of Costa Rica.

A series of specimens from Tierra Colorado, Veracruz have the following characteristics (I am not wholly certain that the form is conspecific with the Panamá species): In these the tympanum is distinctly smaller than eye (3 mm. to 5.5 mm.), its diameter averaging approximately three fifths of eye length. Upper surface finely corrugated with extremely fine granulation on posterior part of back, on forearm and tibia; chin, breast, venter and most of under side of thighs with fine granules and with much larger granules on the outer edge of venter and along the posterior part of

the ventral surface of thigh; vent opening on level of ventral surface of thigh; strongly elevated subarticular and supernumerary tubercles on hand and foot; outer subarticular tubercle on fourth finger double; a very large inner metacarpal tubercle; palmar tubercle small conical scarcely distinguishable from supernumerary tubercles; elbows strongly flexed and protuberant. The eye (red in life) in preserved specimens becomes grayish white; the lateral band is purplish to lavender with two to five diagonal cream lines; there is no longitudinal yellow or cream line on side. A direct comparison of the population from Panamá may show other differences.

Genus PHYLLOMEDUSA Wagler

Type of genus: *Rana bicolor* Boddaert.

Only a single species of this genus is known in Costa Rica. It may be readily distinguished from the species of *Agalychnis* by the absence of webbing on the foot, and absence of vomerine teeth. A vertical pupil is present.

Phyllomedusa lemur Boulenger

Figure 41

Phyllomedusa lemur Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 425 (type locality, Costa Rica).

Agalychnis lemur Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 15; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, pp. 291-292 (Costa Rica); Nieden, Das Tierreich, Lief. 46, Anura I, June 1923, pp. 344-345.

Diagnosis: Slender frog having a narrow snout with subvertical sides; upper part of arms exceedingly slender without pigment; fingers and toes except outer, white above and below; a narrow line of pigment on upper surface of femur; tongue elongate, narrow, notched behind; vomerine teeth absent; anal flap elongated, notched; first toe shorter than second.

Description of species: (R. C. T. No. 772, Isla Bonita, C. R.) Head broader than body, its width at tympanum (9 mm.) a little less than its length (11.5 mm.); eyes strongly protuberant, directed somewhat forward, the pupils vertical; canthus rostralis rounding, the loreal region subvertical, sloping slightly to lip, the region between eye and nostril slightly concave; area about nostril somewhat swollen leaving the tip of the snout with a small emargination; tip of snout sharply truncate; distance from nostril to median notch in the upper lip (2.5 mm.) less than distance between eye and nostril (4.05 mm.); width of an upper eyelid (3.15 mm.) much less than interorbital distance (5.4 mm.); tympanum distinct, its diameter

(2.2 mm.) in eye length (4.5 mm.) approximately 2 times; length of eye equals distance of eye from nostril.

Tongue elongate, pointed anteriorly, somewhat widened and notched posteriorly, free for one fourth of its length; choanae large, lateral, not even partially concealed when seen from below; the vomerine teeth entirely absent; openings of palatal glands not discernible; 72 teeth in maxillary and premaxillary series; skin of dorsal and lateral surface of body smooth; on ventral surface

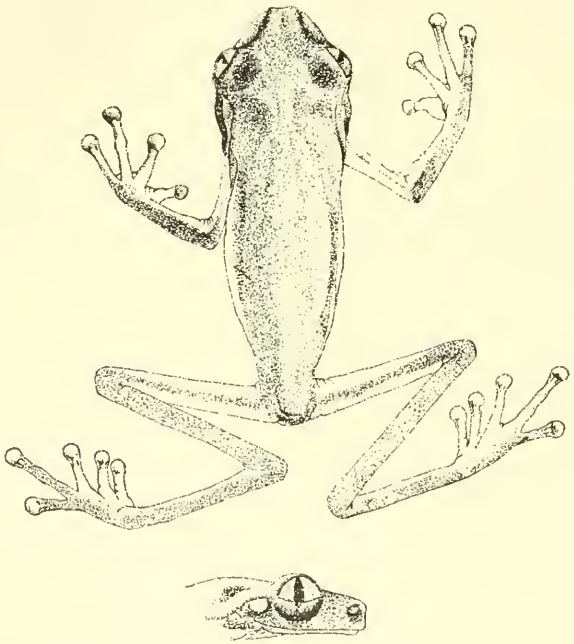

FIG. 41. *Phyllomedusa lemur* Boulenger. R. C. T. No. 772; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 44 mm.

abdomen strongly granular; indistinct granulation on under mesial portion of femurs; anal flap glandular, notched mesially, with some small glandular swellings on each side of anal opening.

Arms long, the upper arm slender, its smallest diameter 1.8 mm.; that of part below elbow 3 mm.; first finger shorter than second; second shorter than fourth; no trace of web; terminal discs widened, that of third finger (2.1 mm.), wider than tympanum; a prominent tubercle at base of first finger; two small palmar tubercles; distal subarticular tubercles large, none bifid; supernumerary tubercles on the palm and on bases of fingers; toes lacking webs; first toe slightly shorter than second; terminal pads a little smaller than those

on fingers; a moderately distinct inner metatarsal tubercle, a small rounded outer; numerous supernumerary tubercles on toes and soles; subarticular tubercles large.

Measurements in mm. of R. C. T. Nos. 613 and 772 respectively: Snout to vent, 33, 44; width of head at tympanum, 7.8, 9; length of head, 10.5, 11.5; arm, 21.5, 29; leg, 50, 65; tibia, 18, 23; tarsus and foot, 22, 29.

Color: (R. C. T. No. 772.) Above nearly uniform magenta-pink with minute greenish (cream in preservation) streaks or clouding discernible under a lens; outer and upper surface of forearm, tibia and tarsus magenta, with a narrow streak of magenta along the median upper surface of femur, extending on outer toe and finger; edge of upper lip white; venter, chin, and under side of limbs white; eye gray; concealed upper parts of toes, foot, and thighs canary-yellow.

This rare species was found on the northern slope of Volcán Poás by Richard Taylor, who obtained two specimens; one from a clump of shrubs, along a small stream at about 2500 feet elevation; a second larger specimen from bushes along a small rivulet at Isla Bonita (5500 ft.) at night. The specimen taken during the day was green above in life. That taken at night was purplish red. The color here recorded is that of the latter specimen.

Genus HYLA Laurenti

Type of the genus: *Hyla viridis* Laurenti.

The composite genus *Hyla* as here treated, is composed of several groups of frogs certain of which I believe merit generic distinction; others perhaps subgeneric designation. Most of the generic groups have already been named by previous authors. The external characters of many of these are known; but the internal, especially skeletal, anatomy is in many cases unknown, and until such a study can be made the limits of the various groups must be in doubt.

KEY TO COSTA RICAN SPECIES OF HYLA

1. A scalloped fringe more or less distinct on outer edge of hand and arm, foot and tarsus; a distinct pollex more or less developed, with or without spine 2

   No scalloped fringe on outer edge of hand and arm, foot and tarsus; a distinct pollex not developed (except in *albomarginata*) 4

2. Outer fingers completely webbed; skin above and below covered with horn-capped granules or tubercles; skin of head involved in ossification of skull bones; strong spine on prepollux; ♂ 100 mm.; Costa Rica . . . . . *immensa*

   Outer fingers not completely webbed 3

3. Skin finely shagreened above, the tubercles and granules may be minutely horn-capped; ventral granules smooth; skin of head involved in skull ossification; outer fingers three-fourths webbed; prepollux distinct but no spine; lips above and below with blackish border; digital discs black above; ♀ 71 mm.; Costa Rica ..... *richardi*

Skin with scattered tubercles above, none with a horny tip; black color absent from tips of digits and from lips; a prepollux present lacking spine; ♀ 31 mm.; Costa Rica ..... *fimbrimembra*

4. A pair of toothlike denticles on medial edge of lower jaw; tympanum more or less concealed; ♂ 32 mm.; ♀ 33 mm.; Costa Rica and Panamá ..... *picadoi*

None or only a single denticle on medial edge of lower jaw; tympanum variable 5

5. A discrete white or yellow stripe from axilla to groin; eye red in life; no dorsolateral light line 6

No discrete white or yellow stripe from axilla to groin; eye not red in life; (a narrow dorsolateral line may be present in *cherrei*, *underwoodi* and *angustilineata*) 8

6. Finger discs larger than tympanum; diameter of tympanum one third of eye; only a vestige of web on hand; an inner tarsal fold present and a more or less distinct outer tarsal fold; body usually dark brown; ♂, 28 mm.; ♀, 34; Costa Rica ... *rufioculis*

Finger discs smaller than tympanum 7

7. Diameter of tympanum one half length of eye; outer fingers one-fourth webbed; no distinct inner or outer tarsal fold; heel to eye; usually olive green in life, becoming reddish lavender in preservative; finger discs one half of tympanum; ♂, 36 mm.; Costa Rica ..... *alleei*

Diameter of tympanum more than half length of eye; digital discs smaller than tympanum; outer fingers two-fifths webbed, toes four-fifths webbed; a moderately distinct inner tarsal fold, no outer; heel to front of eye; green becoming bluish or bluish lavender in preservative; 40 mm.; Costa Rica and Panamá ..... *uranochroa*

8. When leg is laid forward along body, the tibiotarsal joint (heel) reaches tip of snout or beyond tip of snout 9

When leg is laid forward along body, the heel fails to reach beyond nostril 15

9. Smaller forms; heel not or rarely reaching beyond tip of snout; tarsal fold may or may not be present 11

Larger forms; heel in adults extending one or more millimeters beyond tip of snout; a strong tarsal fold 10

10. A black stripe from eye through tympanum and beyond; tympanum five eighths length of eye; discs one half as large as tampanum; markings may or may not be present on back; ♂ 60 mm.; ♀ 73 mm.; Mexico to South America ..... *phaeota*

No black stripe from eye to tympanum; tympanum about one half length of eye; finger discs approximately as large as tympanum; fingers two thirds, toes fully webbed; ♂ 50 mm.; ♀75 mm.; Guatemala? to Costa Rica and Panamá ..... *gabbii*

11. Toes fully webbed; "diameter of tympanum one half area of eye;" fasciculi of vomerine teeth small, between middle of choanae; fingers with web vestige; canthus rostralis angular; 25 mm.; Costa Rica ..... *cherrei*
Toes not fully webbed 12
12. Fingers one-half webbed; webbing of toes and size of discs variable 13
Fingers without or with only web vestige; outer toes one-third to two-fifths webbed; outer finger discs equal area of tympanum; a light dorsolateral line usually present; ♂, 30 mm.; Costa Rica ..... *angustilineata*
13. Tympanum one half eye; toes four-fifths webbed; limbs and feet blackish; 39 mm.; Costa Rica ..... *nigripes*
Tympanum one fourth eye 14
14. Brownish black above; sides and femora deep black; [reach of heel unknown]; 37 mm.; Pico Blanco, Costa Rica ..... *moesta*
Belly unspotted white; no inguinal or lateral spots; [reach of heel unknown]; 37 mm.; Pico Blanco, Costa Rica ..... *monticola*
15. Web between first and second toes proportionally much reduced; canthus rostralis weak or absent; snout flat, low, distinctly longer than eye; fingers free or with only a vestige of a web; no tarsal fold present; some small pustules present in skin 16
Web between first and second toes not reduced proportionally; other characters variable 18
16. Larger; very large choanae, at least five to six times the area of a vomerine tooth fasciculus; palmar tubercles strongly pronounced; outer metatarsal tubercle nearly equal to inner tubercle; finger discs about half area of tympanum; legs strongly barred; some small pustules on back; 45 mm.; Nicaragua to South America ..... *boulengeri*
Smaller; the choanae variable in size; outer metatarsal tubercle very small or absent; finger discs more than half of tympanum; legs not strongly barred 17
17. Vomerine tooth fasciculi about equal to choanae; finger discs larger than tympanum; palmar tubercles not prominent; outer metatarsal tubercle absent; heel to front of eye; green or yellow-green in life, with or without stripes on body; ♀ 35 mm.; Nicaragua to Panamá, perhaps to South America *elaeochroa*
Vomerine tooth fasciculi about half area of choanae; finger discs smaller than tympanum; outer metatarsal tubercle small but distinct; uniform olive, yellowish olive or brownish with or without a bar between the eyes and longitudinal stripes; ♀ 27 mm.; Mexico to Panamá ..... *staufferi*
18. A distinct inner tarsal fold present 19
Usually no distinct tarsal fold present (if present a strong pollical rudiment in females, bearing a spine in males) 22
19. Eyes large, strongly protuberant, distinctly longer than snout; skin strongly pustular on back; finger discs smaller than tympanum; outer fingers about one-third, outer toes three-fourths webbed; first, third and fourth fingers with double subarticular

tubercles; tympanum one half eye length; ♂ 32 mm.; Costa Rica ..... *moraviaensis*

Eyes not especially large or strongly protuberant, not longer than snout; webbing and subarticular tubercles on digits variable.. 20

20. A very strong axillary web; skin above somewhat pustular; finger web vestigial, toes fully webbed; red or orange red color on front and back of thigh and in groin; yellow below; distal subarticular tubercle single; ♀, ♂, 45 mm.; South Mexico to Costa Rica ..... *loquax*

Axillary web, if present, scarcely discernable 21

21. Most distal subarticular tubercles double; fingers one third or more webbed; skin not pustular or tubercular above; no orange or red coloration; ♂ 27; ♀ 32 mm.; South Mexico to Costa Rica (perhaps to and into South America) ..... *ebraccata*

Fingers one-third or more webbed; toes two-thirds to three-eighths webbed; arms of males thickened; color variable, often with spots forming an hourglass-shaped figure, or olive gray with a dark lateral band from axilla to groin; ♀ 46 mm.; Costa Rica and Panamá ..... *pseudopuma*

22. The underside, front and back of arm granular, like venter. Tympani more or less directed upward; a pair of strong tubercles or ridges below vent; ♀ 25 mm.; Costa Rica and Panamá. *zeteki*

Arm not granular like venter; tympani directed laterally; no special tubercles or ridges below vent 23

23. A pollex present bearing spine; a narrow glandular lateral fold; 48 mm. ..... *albomarginata*

No pollex present, or pollical spine; no narrow glandular dorsolateral fold 24

24. Snout narrowed, strongly projecting beyond lip; nostril much nearer the eye than median point on upper lip 25

Snout not especially narrowed and not or scarcely projecting beyond lip 26

25. Tympanum less than half of eye length; finger discs larger than the tympanum; strong vestige of a web (less than one-fourth webbed) between outer fingers; a thickened ridge on outer edge of tarsus; first and third and fourth fingers usually with bifid subarticular tubercles; a strong canthus; dark spots or flecks on venter; ♀ 35 mm.; Costa Rica ..... *rivularis*

Tympanum one half of eye length; outer fingers one-half webbed; double tubercle under fourth finger usually; moderately sharp canthus rostralis; no outer tarsal fold; an elongate dorsolateral light spot; 26 mm.; Costa Rica ..... *debilis*

26. Bright yellow in life with a cream line beginning behind eye and continuing onto shoulder; no distinct tarsal folds but a thick low elongate ridge may be discernible; a pair of diagonal skin folds from sides of vent diverging posteriorly; Costa Rica. *alvaradoi*

Not bright yellow in life or white in preservative; no cream line behind eye 27

27. Strongly defined lateral black marks on sides and yellow spots on front and back of thigh; ♂ 26 mm.; ♀ 29 mm.; Pico Blanco, Costa Rica ..... *pictipes*
Not so colored 28
28. A small cream or yellow frog with a network of black on back; no dorsolateral darker stripe bordered by light above; ♀ 24 mm.; Central America ..... *phlebodes*
Not so colored 29
29. Small frog with a darker lateral stripe on head and body separated from dorsal color by a more or less definite lighter line. Dorsal coloring without reticulum of black or distinct darker spots. Costa Rica ..... *underwoodi*
Larger, without a lateral stripe; light brown with usually two irregular dorsal stripes joined at one point; tympanum two thirds of eye length; discs smaller than tympanum; fingers less than one-fourth or one-fifth webbed; outer toes two-thirds webbed; ♂ 44 mm.; Costa Rica ..... *wellmanorum*

Hyla immensa sp. nov.

Figures 42, 43

Type: Kansas Univ. Mus. Nat. Hist. No. 30404; Inter-American Institute of Agricultural Sciences, Turrialba, Costa Rica, June 25, 1951; Edward H. Taylor, coll.

Diagnosis: A large frog (♂ , approximately 100 mm. snout to vent); the skin of dorsal surface of head co-ossified with skull; skin everywhere covered with rounded or spiny tubercles capped with blackish horn; tympanum distinct, somewhat overhung by a supratympanic ridge; an irregular scalloped fringe on outer edge of foot, tarsus, and to a lesser extent on hand and arm; fingers and toes fully webbed except between first and second fingers; prepollex bearing a subarticular tubercle on its base, terminating in a heavy pointed spine at right angles to first finger; openings from mouth to vocal sacs almost completely behind tongue.

Description of type: Head large, its width (38 mm.) much greater than its length (30 mm.); eyes moderately prominent, the width of an eyelid (8 mm.) contained in the distance between eyelids approximately 1.8 times; canthus rostralis distinct, its edge slightly rounded and curving to nostril; snout short, truncate, nose-like, the swellings about nostrils prominent, terminal with a depression between them; mouth broadly rounded; upper part of loreal region nearly vertical, then sloping obliquely to edge of lip; tympanum large, sharply distinct, the edges elevated, its diameter (5.5 mm.) more than half of eye length (8.2 mm.); distance between eye and tympanum approximately equal to diameter of latter; a

strong, ossified, supratemporal ridge overhangs the tympanum and continues to a point behind it, its outer edge with tubercles.

Tongue broad, slightly notched behind, the anterior three fourths circular in outline, irregular posteriorly, no part of it free; vomerine tooth fasciculi lying between posterior part of choanae, nearly contiguous mesially, but separated from choanae by half the length

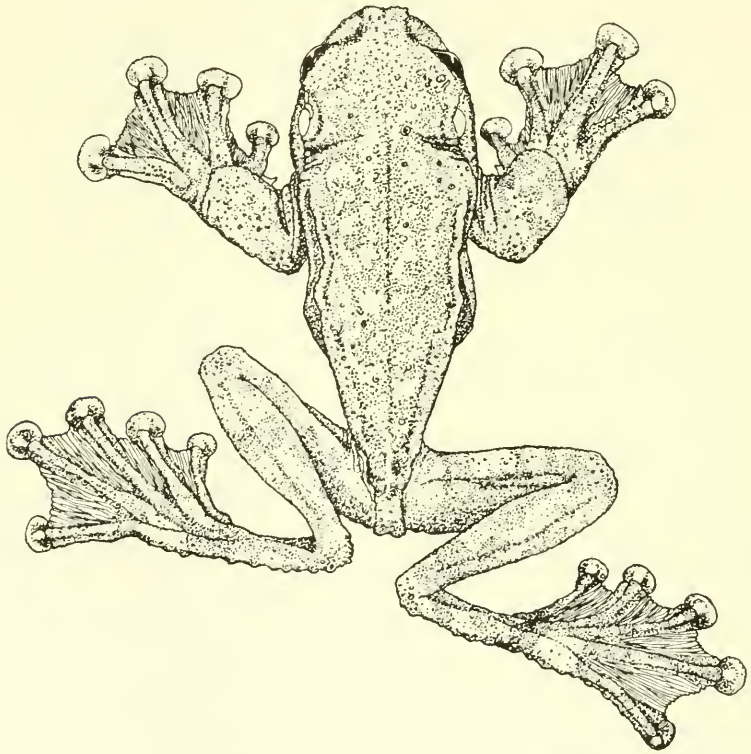

FIG. 42. *Hyla immensa* sp. nov. Type ♂. K.U.M.N.H. No. 30404; Turrialba, Costa Rica; snout-to-vent length, 100 mm.; dorsal view.

of a fasciculus; the teeth form a slightly curving line which lies just behind the posterior level of choanae; Eustachian tube openings smaller than choanae.

Arm greatly thickened and more or less fixed, being held close to body; fingers with transversely oval pads, their width being equal to or greater than their length; web between the two inner fingers equals half length of first finger; disc of first finger about half the area of that on second finger; three outer fingers webbed to base of discs, except outer side of second which has web attaching

to side of disc; prepollex with a strong, exposed spine placed at right angle to first finger; a well-developed subarticular tubercle at base of prepollex; subarticular tubercles under digits single; a few supernumerary tubercles moderately distinct; outer toe with a distinct fringe not continuous with a scalloped ridge on under surface of forearm.

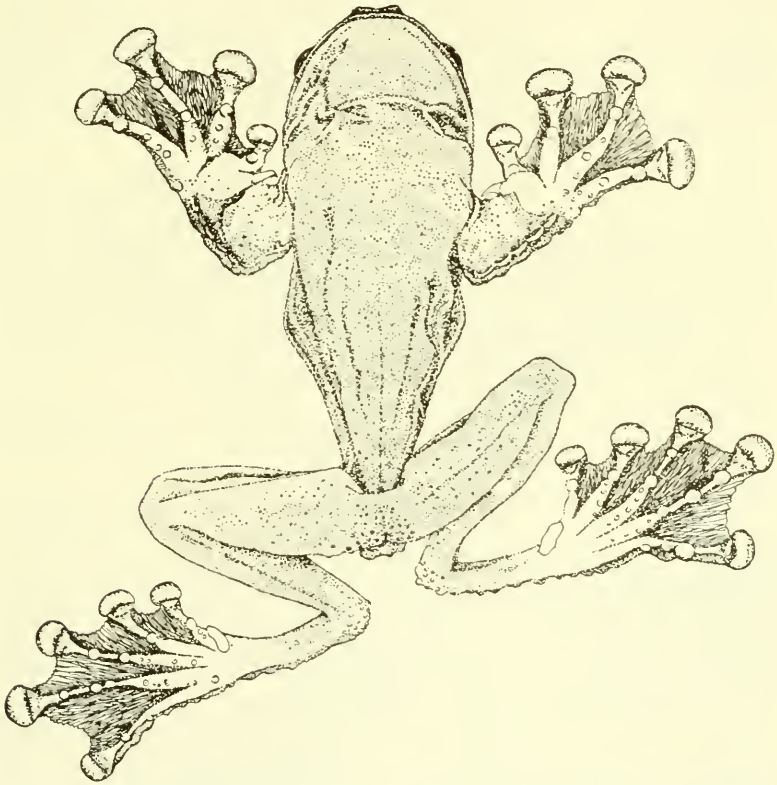

FIG. 43. *Hyla immensa* sp. nov. Type ♂. K.U.M.N.H. No. 30404; Turrialba, Costa Rica; snout-to-vent length, 100 mm.; ventral view.

Legs moderate, the tibiotarsal joint reaching to near middle of eye; digital pads distinctly larger than tympanum but smaller than those on fingers; toes fully webbed, the webs reaching on sides of discs; inner metatarsal tubercle moderately large, outer small, rounded; an irregular fringe on outer toe and along outer edge of tarsus; a well-defined inner tarsal fold extends from tubercle to heel; no outer fold; when legs are placed at right angles to body, the heels strongly overlap.

Skin everywhere on dorsal surfaces with tubercles varying much in size, all larger than those on venter; tubercles capped with dark brown or black horn; skin on under surfaces of chin, breast, belly and under thighs with minute tubercles all of which bear black, rough-surfaced, horny caps; under surface of hands and feet with none or but few horny tubercles.

Skin of head coalesced with skull bones; back flat, the skin on dorsum more or less completely joined to back; body angular with a suggestion of a dorsolateral fold on edge; a prominent lateral irregular skin fold from axilla not reaching groin; external folds of vocal sac evident but not ample; no transverse chest fold; anal opening on a small fleshy protuberance.

Color: Above lavender-brown, the legs somewhat lighter and indefinitely barred; discs of fingers blackish above, the webs darker than digits; sides brown with some black markings more or less light-edged; venter, chin, throat and concealed parts of limbs black or blackish brown with a few white irregular areas under arms and on breast, and smaller flecks of white under thighs, tibia and tarsi. The discs are not darker than remainder of digits.

Measurements in mm.: Snout to vent, 100; head width, 38; head length, 30; width of outer finger discs, 8; arm length (estimated), 70; leg, 157; tibia, 52; tarsus and foot, 74.

Relationships: The species belongs in the group of hylid frogs that includes *Hyla miliaria, fimbrimembra, richardi,* and *phantasmagoria,* and probably is most closely related to the latter. It differs from the latter in the character of the tuberculation of the skin, the dorsal tubercles being larger than those on venter; the prepollex terminates in a sharp exposed spine instead of ending bluntly without a spine; the limbs are shorter, the heel reaching middle of eye rather than beyond snout. It is probable that numerous other differences exist but the type description of *phantasmagoria* omits most measurements and certain pertinent characters such as vocal slits, choanae, tongue, etc. The greatly thickened forearm, whose diameter is only a little less than the greatest diameter of the thigh, probably represents another difference. The discs on toes are differently shaped.

Remarks: The type specimen was obtained from mud at the bottom of a water-filled cavity in a tree, about five feet above the ground. I was prompted to investigate the cavity solely by curiosity since the specimen had not been seen. It is presumed that it had been perched near the surface of the water and on my approach had

submerged quietly. Once in Mindanao, P. I., in just such a cavity I had discovered *Hazelia spinosa,* a new genus and species of rhacophorid frogs.

Hyla richardi Taylor

Figure 44

Hyla richardi Taylor, Copeia, 1948, No. 4, Dec. 31, pp. 233-234, fig. 1 (type locality 2 mi. west Isla Bonita [American Cinchona Plantation] Caribbean slope, Volcán Poás, Costa Rica).

Diagnosis: A large hyla with the skin of head co-ossified with skull; tongue longer than broad, not or scarcely emarginate behind; snout not especially blunt, the canthus distinct; tympanum distinct;

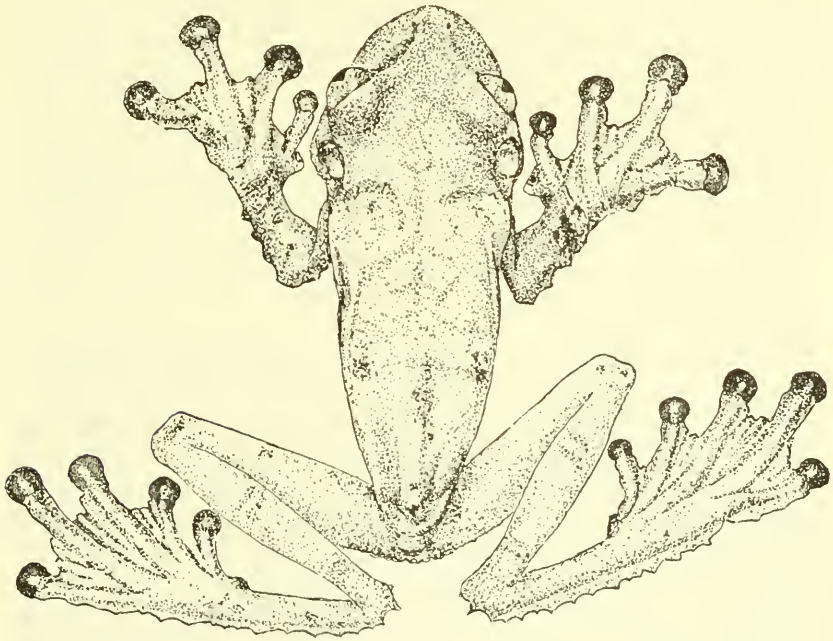

FIG. 44. *Hyla richardi* Taylor. Type. R.C.T. No. 761. Two mi. W Isla Bonita, Volcán Poás; actual snout-to-vent length, 71 mm.

outer fingers three-fourths webbed; toes about four-fifths webbed but reaching the disks only on one side of digits; a serrate fringe on outer side of limbs and outer digits; vomerine teeth between choanae; skin without warts or papillae but minutely shagreened, the minute pustules, visible only under a lens, capped with brown horn; a pollex rudiment but no spine evident in type (female).

Description of type: Length ♀ 71 mm., probably nearly fully grown; head a rather pointed oval, the front of the snout sloping

down to lip; canthus distinct, very slightly rounded; lores broadly sloping, distinctly concave; width of upper eyelid contained in the interorbital distance one and one-fourth times; tympanum distinct, directed slightly upward, its diameter contained in eye diameter one and one-half times; most of the skin of the dorsal surface of the head involved in cranial ossification; a pair of depressions behind skull giving a constricted appearance to head; a well-defined supratympanic fold curving over tympanum and extending back to shoulder; no median elevated area on occiput.

A pair of vomerine elevations bearing seven or eight teeth between choanae, separated from each other by a distance equal to their distance from choanae; palatal groove wanting, the palatal glands opening by an irregular series of small perforations; longitudinal diameter of choanae contained in the distance between them, three and one-half times; pupil horizontal, somewhat diamond-shaped.

Skin above finely shagreened, the tips of the minute pustules capped with brown horn, in some regions producing minute pointed spines (these visible only under magnification); a few indistinct tubercles on forearm; skin on chin nearly smooth; abdomen, as well as two thirds of ventral area of thigh, strongly and uniformly granular; a few granules below anus more or less fused on each side, separated by a median groove.

Arms short, upper arm especially short and slender; hands and feet not unusually large; the tibiotarsal articulation reaching to near anterior corner of eye; when leg is folded at right angles to body the heels overlap 4 to 5 mm.; arm with a serrate fringe from elbow to terminal disk of fourth finger; largest finger discs larger than tympanum, the discs wider than long; a well-defined, blunt, pollex rudiment without external evidence of a spine (may be present in male); first and second fingers with a rudimentary web (one fourth or less); outer fingers nearly three-fourths webbed; subarticular and supernumerary tubercles; palmar tubercle or pad much divided.

Legs moderately slender; a serrate fringe from tibiotarsal articulation to disc of fifth toe; discs on toes smaller than those on fingers, the web reaching or nearly reaching discs on outer side except on fourth toe where the membrane reaches the level of the distal subarticular tubercle; subarticular tubercles small under foot; numerous supernumerary tubercles on sole; inner metatarsal tubercle moderately large, the upper end somewhat free; a small indistinct rounded outer tubercle; heel with two or three conical tubercles.

Color: In life, nearly uniform lavender-brown with very indistinct darker markings; discs on all fingers and toes blue-black; edge

of lower jaw bluish black; a narrow line of black on edge of upper lip; throat yellow-brown with fine purple reticulation; venter and underside of thighs lavender-brown with cream marks; under side of hands and feet lavender; no light mark at vent.

In preservative, a faint trace of darker bars is evident on limbs, and there is some black pigment scattered on back; fringe on limbs colored like body.

Measurements in mm.: Snout to vent, 71; width of head, 28; length of head, 23; elbow to tip of longest finger, 37; femur, 32; tibia, 37; foot, 53.

Remarks: Hyla richardi differs from *H. fimbrimembra* and *H. miliaria* in having the derm of the head co-ossified with the skull; in lacking warty tubercles or lamellate papillae or tubercles; in having the surface of back, sides and head covered with minute pustules, many, perhaps most, of which are surmounted by minute horny spicules, visible only under a lens, but sensible to touch. The black coloration of the dorsal surface of the digital pads is characteristic. From *H. phantasmagoria* it differs in having much smaller feet and digital discs, and in lacking a casque.

Hyla fimbrimembra Taylor

Figure 45

Hyla fimbrimembra Taylor, Copeia, 1948, No. 4, Dec. 31, pp. 235-238, fig. 2 (type locality Isla Bonita, American Cinchona Plantation, Caribbean slope of Volcán Poás, Costa Rica, 5200 ft. elev.)

Diagnosis: Tongue broader than long, somewhat notched behind; tip of snout rounded, elevated, quadrangular, the canthus somewhat rounded; tympanum distinct; outer fingers one-half to two-thirds webbed; toes about three-fourths webbed; a strongly serrate fringe on side of outer finger and forearm, and on outer toe and outer side of tarsus to heel; skin of back and limbs tubercular; a pollex rudiment present, pointed and free at tip without spine (spine possibly present in male).

Description of type: Type ♀ 31 mm. long from tip of snout to vent, not full grown; front end of snout sharply truncate, the nostrils almost directly above edge of lip; area about nostrils swollen, the front edge of snout vertical; canthus rostralis rather rounded; nostril nearer median edge of lip than eye; loreal region sloping to lip, not or scarcely concave; smallest interorbital distance one and one-fourth times width of an eyelid; tympanum very distinct, directed somewhat upward, broader than high, its greatest diameter one and two-thirds times in greatest diameter of eye; a strong supratympanic fold arching up and over tympanum, and continuing to above arm

insertion (almost angular on left side); a transverse depressed area, bordering skull, behind and above tympanum, suggesting a constriction immediately behind head; a median elevated oval area from forehead to occiput, and a depressed area bordering eyelids; pupil horizontal, somewhat quadrangular; tongue one fifth broader than long, free for about one fifth of length, notched or emarginate behind; palate deflected downward from point behind level of choanae, the palatal groove distinct; two very distinct, rounded,

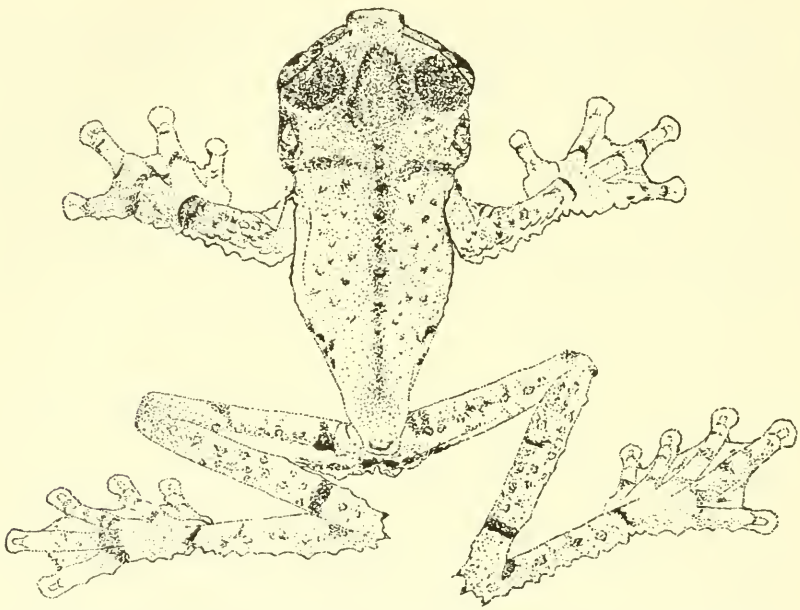

FIG. 45. *Hyla fimbrimembra* Taylor. Type. R.C.T. No. 764. Isla Bonita, Volcán Poás; actual snout-to-vent length, 31 mm.

elevated areas between choanae, much closer to each other than to choanae, each about as large as a choana but each apparently lacking vomerine teeth (none can be seen or detected below surface by dissection; this may be a juvenile condition); choanae higher than wide, their longitudinal diameter in the distance between them about three times.

Upper arm rather weak; forearm heavy, with a strong, serrate fringe or fold on back edge of forearm and outer edge of fourth finger; inner finger with a distinct pollex rudiment, the tip free (condition of male unknown; may include spine); first finger much smaller than second; between first and second fingers about one-fifth

webbed, a slight fringe extending to terminal pad of first, and more than half length of second; second and third fingers a little more than half webbed, the web with a small smooth fringe reaching to near base of terminal discs; outer fingers two-thirds webbed, web extending beyond level of distal subarticular tubercles; distal subarticular tubercles well developed but rather small; numerous supernumerary tubercles; terminal discs of three outer fingers about equal to (or fourth, a little greater than), diameter of tympanum.

Leg moderate, tibiotarsal articulation reaching to nostril; half webbed between first and second toes; between four outer toes at least three-fourths webbed; diameter of largest terminal discs a little less than diameter of tympanum; subarticular tubercles small, distinct; a well-developed, terminally free, inner metatarsal tubercle; outer tubercle, if present, indistinct; many supernumerary tubercles; a very indistinct inner metatarsal fold; outer metatarsal fold developed into a conspicuous serrate skinfold or fringe extending length of tarsus and outer toe; heel with strong, pointed, soft tubercles; heels overlap about 3 mm. when legs are folded at right angles to body.

Skin on back and upper part of sides rather rough with scattered small warts or tubercles that are also present on eyelids, back of head, on exposed surfaces of limbs, and even on sides of head and snout where they are smaller; chin finely and rather indistinctly granular; belly with pavementlike granules; likewise granular under thighs; a thickened glandular fold, divided medially by a groove, below anal opening; from each end of fold a row of conspicuous granules ascend on either side, tending to curve above the vent; opening of vent near upper level of thigh.

Color in life: Brownish gray above, the extremities more ashen gray; chin and venter white with strong lavender reticulation on chin; on edge of underside of arm and tarsus a deep lavender stripe; elevated area on head blackish brown; limbs very faintly barred; some small brown flecks forming a short diagonal line on side; some flecks of brown in groin.

In preservative the dorsal color is somewhat lavender brown save that eyelids are dark and a slight median darker mark is evident behind occiput; a distinct blackish band present on wrist; a strong dark band on lower tarsus and one on proximal part of thigh; transverse bands evident on toes; metatarsal and metacarpal areas lighter; a grayish white spot below eye; yellow wash in groin and on part of anterior surface of thigh; around vent a pure white mark with two small black spots above, and with an indefinite darker

line running laterally for a short distance on back of thigh; tip of heel white; dorsal surface of discs cream.

Measurements in mm.: Snout to vent, 31; width of head, 12.5; length of head, 11; arm and hand, 18; leg, 52; foot and toe, 24.6; tibia, 17; femur, 15.6.

Remarks: The relationship of this species is with *Hyla miliaria* (Cope), a frog from Nicaragua, and with *Hyla richardi* described in this paper. The former is, I believe, known from only a single type specimen (U. S. National Museum No. 14193). I have recently carefully examined the type and compared *fimbrimembra* with it. *Hyla miliaria* has the three outer fingers and the toes completely webbed, while *fimbrimembra* has the outer fingers little more than half webbed, the toes four-fifths webbed. The skin of the head, the back and the limbs is covered with low, warty tubercles, while in *miliaria* the dorsum is covered with leaflike papillae or subspinous projections, most numerous on head above tympanum. The color of *miliaria* is dark plum or mulberry, with obscure coarse reticulations of a darker shade. The color on the ventral surface is yellow. The webs on the feet are plum-color except that yellow borders are present and the digits themselves are yellowish on the underside. The dermal processes are often light yellow in color. There are no black spots on the digital expansions. A white spot is present below the vent and the thigh is blackish behind. The tibia is dark.

The differences in color, in the amount of webbing between the toes, and the character of the skin distinctly separate the two forms *miliaria* and *fimbrimembra*. Numerous other differences are in evidence when the two descriptions are compared. Differences between *fimbrimembra* and *richardi* are discussed under that species.

The specimen was collected at night, clinging to a small plant bathed in the spray of a waterfall.

Hyla picadoi Dunn

Figure 46

Hyla picadoi Dunn, Copeia, 1937, no. 3, Nov. 19, p. 164 (type locality "a little above the farm of Manuel Acosta" 2140 m. Volcán Barba, Costa Rica. E. R. Dunn and Manuel Valerio, colls.).

Diagnosis: This medium-sized species (♂ 32 mm., ♀ 33 mm.) may be diagnosed by the following characters: tympanum covered with skin, concealed (or faintly visible); a glandular area evidenced by enlarged granules or pustules in the temporal region, continues back, below the supratemporal fold, to some distance on side; snout short with a small distinct "nose"; vomerine teeth be-

tween inner level of choanae, but behind choanae; front of lower jaw with two toothlike projections; arm granular on under side.

Description of species: (Univ. Mich. Mus. Zool. No. 70179, paratype.) Head broader than body, its width (10.4 mm.) greater than its length (9 mm.); canthus rostralis much rounded and curving from eye to nostril; area about nostrils slightly swollen, but no depression evident between them; upper loreal region somewhat concave, lower sloping obliquely to lip; length of eye (2.9 mm.)

FIG. 46. *Hyla picadoi* Dunn. Paratype. U.M.M.Z. No. 70179; 2140 m. Volcán Barba, Costa Rica; actual snout-to-vent length, 29 mm.

distinctly greater than length of snout (2.7 mm.); distance between nostrils (2.4 mm.) much less than distance of eye to nostril (3 mm.); a slight vertical ridge on the tip of snout not reaching lip, but seen from above has the appearance of a "nose"; snout extending .8 mm. beyond edge of lip; tympanic area and area immediately behind this covered with a soft granular skin obscuring the tympanum; a strong, discrete tympanic fold curves back over tympanic area to angle of jaw, with one or two enlarged tubercles in front of its terminus; width of an eyelid (2.8 mm.) much less than interorbital distance (3.9 mm.); nostrils terminal, equidistant between eye and the notch in upper lip; vomerine teeth in two somewhat rounded

fasciculi separated by about half the width of one fasciculus and from choanae by twice this distance.

Choanae smaller than fasciculi, separated from each other by a distance approximately 4.5 times width of a choana; no distinct groove on palate, the palatal glands seemingly opening by separate ducts; tongue thick, subquadrangular, wider behind than in front, wider than long, not or scarcely free behind. Arm moderate, the wrist reaching slightly beyond snout; terminal discs on hand 1.5 mm. wide; vestige of a web between the first two fingers; other fingers little more than one-fifth webbed, the palm strongly and uniformly granulate; inner metacarpal tubercle elongate, thickened, causing first finger to be very wide at base; fringes on fingers continuous with the edge of the discs; finger discs rather large, about half width of eye; distal subarticular tubercles of two outer fingers divided, those on inner fingers more or less bifid; palmar tubercle quadripartite, scarcely distinguishable from supernumerary tubercles; under side, front and back of arm strongly granulate like the venter.

Leg rather short, the heel reaching to middle of eye; legs folded at right angles, the heels overlap nearly 4 millimeters; web vestige between first two toes; between second and third, less than one third; between outer toes, about one-half webbed, the discs as large or only slightly smaller than discs on fingers; a prominent, much widened tarsal fold; inner metatarsal tubercle equal to one third length of first toe; outer tubercle smaller, distinct; sole of foot strongly granular.

Skin above on head and back smooth, shiny; temporal region and sides with large irregular granules, which tend to merge into the lateral and ventral granulation; no axillary web present; chin indistinctly granular; breast, belly, and underpart of thigh strongly granular; anal flap short, the skin above and below fluted; a small specialized gland in axilla formed by fusion of granules; area below vent with enlarged, but not otherwise distinctive, granules; the loose skin forms a thin fold along the side of the body (perhaps not a "permanent" character).

Color: Light brown above with a slightly darker area on occiput and an indefinite darker median line; an irregular dark brown dorsolateral streak; tip of snout and loreal region darker; venter light without pigment as are the hands and feet; front and back of thigh uniformly but sparsely pigmented; on the tibia there is some marbling with darker brown. The swollen area behind eyes lighter than remainder of occiput.

Measurements of type and paratype[*] *in mm.:* Snout to vent, 32, 29; width of head, 12, 10.4; length of head, 10.4, 9.6; interorbital width, 4.8, 3.9; eyelid, 2.5, 2.5; between nostrils, 2.2, 2; length of eye, 3, 2.9; length of snout, 2.8, 2.7; arm, 17, 18; hand, 9, 8; leg, 49, 43; tibia, 16.5, 14.8; foot and tarsus, 25.5, 22.

Remarks: The male type has elongated vocal slits and one fasciculus of the vomerine teeth seems to be missing. The palate is convex between the orbits. The palmar tubercle is bifid; the muscular areas behind the eyes are elevated somewhat, and an area on the top of the head is nearly flat. The granules in the axillary regions are quadrangular.

Specimens have been examined from El Gallito located on the east end of Volcán Barba, 1900 m. elevation. In these the eye is a little longer than the snout; the canthus is more distinct, and the nostril slightly closer to the eye than to the median notch in the lip. The dorsal surface of the back shows some small granular tubercles. There is an indistinct ridge from the nostril across the loreal region to under the edge of the eye, and a slight depression on the snout. The vocal sac is evident externally and is limited posteriorly by a fold on the neck rather than on the breast; the fasciculi of the vomerine teeth are completely behind the level of the choanae. They are conical, bearing three (or two) teeth. The snout is very short and the palate anterior to the choanae is obscured by the maxillary shelf.

The paratype specimen has more markings on the back than the type has. There is an indefinite dorsolateral mark on each side extending (more or less brokenly) to the rump and another mark following the temporal fold from the eye to some distance on the side. There are a few dorsal spots on the head.

The relationship of this small species is obscure. The paired toothlike processes in the lower jaw are not, to my knowledge, present in other Central American species.

Hyla rufioculis sp. nov.

Figure 47

Type: K.U.M.N.H. No. 28216, Isla Bonita (American Cinchona Plantation), eastern slope of Volcán Poás, Costa Rica, July 28, 1947, Richard C. Taylor and Edward H. Taylor, colls.

Paratypes: K.U.M.N.H. Nos. 28204-28210, July 14, 1947; Nos. 28211-28215, 28217-28222; R.C.T. Nos. 430, 512, 513, 515, 518, 520, all from Morehouse Finca, four and one-half miles S of Turrialba,

[*] U. M. M. Z. No. 70179.

July 15-16, 1947; Nos. 31072-31078, Moravia, Aug. 16, 1951; R.C.T. Nos. 2437-2438, 2441, 2443-44, 2446-47, 2449, 2454, 2457, Isla Bonita, July 22 to Aug. 3, 1947.

Diagnosis: Small species, 34 mm. ♀ ; prominent eye, red in life; head depressed, wider than body; olive or brownish above, with a narrow white labial line connecting with a larger white spot below eye, and continuing to groin; this bordered below by a narrow dark pigmented line; fingers with a vestige of a web; outer toes at least three-fourths webbed; a narrow inner and a narrow outer tarsal fold; choanae large; vomerine teeth in two fasciculi between

FIG. 47. *Hyla rufioculis* sp. nov. K.U.M.N.H. No. 28216; Isla Bonita, Volcán Poás, Costa Rica; snout-to-vent length, 34 mm.

choanae, about one third size of choanae. Males with vocal slits, and an external vocal sac.

Description of type: Head broad, broader than body, its width (12 mm.) greater than its length (10.8 mm.); eyes very prominent; interorbital area slightly depressed; a depressed area between the canthi extending between swollen areas about nostrils, and continuing on to front of snout; canthus distinct, rounded, curving forward to a point above nostril; loreal region concave, the upper part sloping abruptly, the lower part, obliquely, to lip; tip of snout rounding in profile, extending about one millimeter beyond mouth. Tympanum distinct, its upper third covered by a strong slightly overhanging, supratympanic fold that curves down in front of arm insertion; distance between tympanum and eye (2.55 mm.) approxi-

mately twice diameter of tympanum (1.3 mm.); length of eye opening (4.1 mm.) more than three times diameter of tympanum; length of snout, 3.8 mm., the distance between eye and nostril, 3.1 mm.; width of an eyelid (flat) (3.1 mm.) less than interorbital distance (4 mm.); distance between nostrils, 3 mm.; trace of a fine ridge from nostril back to eye; choanae large, a little longer than wide, separated from each other by a distance (3.3 mm.) little more than three times the greatest diameter of a choana; vomerine teeth in two fasciculi between choanae, separated from each other by width of one fasciculus and from choanae by a distance equal to length of one and one-half fasciculi; palatal glands open into a sinuous, discontinuous groove, a little closer to the choanae than to end of palate; transverse palatal ridges strongly elevated; tongue longer than wide, distinctly notched or emarginate behind, free for one fifth of its length (males with vocal slits, and a vocal sac).

Arm rather long, the wrist extending two millimeters beyond tip of snout; inner fingers with a vestige of a web; three outer fingers about one-fifth to one-sixth webbed; discs large (1.6 mm.), much larger than the tympanum; fringes on edges of fingers narrow; inner metacarpal tubercle well developed; the palmar tubercle tri- or quadripartite, not especially distinct; a more or less continuous fold under forearm; distal subarticular tubercles of two outer fingers bifid.

Leg with the heel reaching to the middle of eye; inner toe about one-third webbed; four outer approximately four-fifths webbed, the webs reaching to near the discs, but deeply excised; a small, rounded, inner metatarsal tubercle; a small but distinct outer tubercle; a fine, angular, inner tarsal fold, and a similar outer tarsal fold continuous with a slight fringe on outer edge of outer toe; legs folded at right angles to body, the heels overlap 4 mm.

Skin on dorsum and sides generally smooth but under a lens appearing finely corrugated; under part of thighs, venter, and chin granular, the breast wrinkled without a distinct fold; under surface of arms smooth; anal flap short, the vent high, immediately followed by a groove, flanked by a pair of large tubercles (partly covered by the anal flap) and a slight ridge terminating behind in another pair of tubercles; the anterior tubercles more or less fluted; a few other slightly enlarged tubercles or granules, scattered on ventral surface of thighs; granules on palm and sole rather ill-defined; practically no trace of an axillary web.

Color: Above nearly uniform red-brown on dorsum, upper part of sides and on dorsal surfaces of limbs. A cream line on lip con-

necting with the subocular eye-spot, and continuing along middle of side to groin; venter yellow-flesh; concealed parts of limbs canary-yellow, the color under hand and feet less intense; posterior face of femur pigmented.

Measurements in mm. of Hyla rufioculis sp. nov.

	Type	28215	28207
Snout to vent	34	28	28
Length of head	10.8	10	9.8
Width of head	12	10.4	10
Length of snout	3.8	3	3
Length of eye	4.1	3.6	3.7
Tympanum	1.25	1.1	1.2
Interorbital width	4	3	3
Arm	21	18	17
Hand	9.5	8.4	8
Leg	51	45	44
Tibia	17	15	15
Foot and tarsus	22	19	18.8

Remarks: The series of specimens taken at the Morehouse Finca near Turrialba differ somewhat from those taken at the type locality. The measurements are nearly identical, but the specimens are an intense brown with some scattered darker flecking visible when the specimens are submerged in water. The dark stripe below the lateral yellow stripe may be all but obsolete in some, while in others it is present or consists of small spots or flecks. The chin occasionally has small spots. The breast is granular and the under surfaces of the arms show some trace of fine granulation. The skin is much more strongly corrugated on the dorsal and lateral surfaces.

Topotypic males differ in having a relatively narrower interorbital width and slightly larger eyes; vocal slits are present but there is no external evidence of a vocal sac.

Specimens were found along small rivulets at night, calling from the leaves of low plants. The call is reminiscent of *Hyla miotympanum*, with which species it is probably related.

Two other Costa Rican forms that may be confused with these are *Hyla uranochroa* and *Hyla alleei*, the latter occurring in the same immediate locality as *rufioculis*. The differences from this latter species are discussed under *H. alleei*.

In *Hyla uranochroa* the following differences obtain: eye silvery in color; tympanum large, separated from eye by a distance a little less than its own diameter; posterior face of thigh unpigmented; a strong white line covers anterior part of anal flap; area about vent

deep brown; tubercles below anus covered with an enamel white; chin pure white; a pure white line on lip widens slightly under eye and continues to groin, not bordered below by a dark stripe; size larger, 39 mm., head width 14 mm. in females.

The specimens from the Morehouse Finca and Moravia were found on water plants in small spring-fed streams. Specimens from Isla Bonita were taken from the immediate environs of a small spring.

Hyla alleei sp. nov.

Figure 48

Type: R.C.T. No. 775. American Cinchona Plantation (Isla Bonita) eastern slope of Volcán Poás, Costa Rica. Richard C. Taylor coll., July 28, 1947.

Paratype: R.C.T. No. 774. Same data and collector.

Diagnosis: Medium sized frogs (36 mm.) with a much flattened head and body; above, olive green in life; canary yellow below (reddish lavender in preservative); *eye red in life;* tympanum longer than high with a sharp rim, its diameter more than half length of eye; eye shorter than snout; vomerine teeth in tiny fasciculi between choanae, each about one fourth size of large choana; outer fingers less than one-third webbed; toes except inner, about three-fourths webbed; heel to front level of eye; finger discs about one half of tympanum; pupil horizontal.

Description of type: Head and body depressed, the eyes prominent; canthus rounded, curving slightly; width of head (12 mm.) a little less than length (12.5 mm.); area about nostrils swollen, but a very indistinct depression between them; nostrils much closer to notch in upper lip than to eye; tympanum large, a little longer than high (2.35 mm. x 2.1 mm.), its upper edge concealed by the supratympanic fold, directed slightly upward, and separated from eye by a distance equal to nearly two thirds diameter of tympanum; eye large, its length (4 mm.) distinctly less than length of snout (5 mm.) but nearly equal to its distance from nostril; interval between nostrils (3 mm.) much less than eye length; width of an eyelid (3 mm.) less than interorbital width (4 mm.); canthus rostralis rounded, upper part of loreal region nearly vertical, lower part sloping obliquely to lip, the region strongly concave; profile of snout curving somewhat outward beyond nostrils to lower lip; snout not or scarcely projecting.

Choanae large, longer than wide, separated by a distance equivalent to three times length of one choana; vomerine teeth in two

tiny elevated fasciculi, each about one fourth size of choanae and separated from them by a distance twice length of a fasciculus and from each other by once this distance; tongue a little longer than wide; a pair of vocal slits in mouth almost entirely behind posterior level of tongue; palatal glands opening into two transverse grooves, curving forward closer to anterior part of palate than to anterior level of choanae; openings of the Eustachian tubes equally as large as choanae.

Arm with wrist reaching slightly beyond tip of snout; upper arm very slender, forearm relatively much thickened (as in *Agalychnis*);

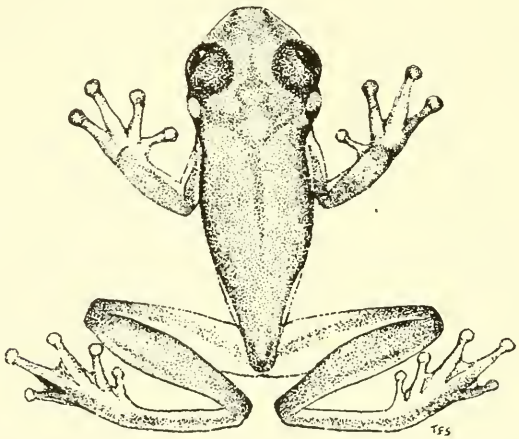

FIG. 48. *Hyla alleei* sp. nov. R.C.T. No. 774, Paratype; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 35 mm.

a very slight axillary web; between inner fingers scarcely a trace of web; three outer fingers a little more than one-fourth webbed; thumb seemingly not opposable; a large inner metacarpal tubercle at side of base of first finger; a very small area of nuptial asperities scarcely darker than surrounding tissue; distal subarticular tubercle of fourth finger on right hand bifid, single on left hand; palmar tubercle indistinctly tripartite; numerous granules on palm; a continuous ridge on under side of arm; skin not granular on under side of arm.

Leg short, the heel reaching to anterior edge of eye; no distinct inner tarsal fold or ridge; no outer fold; inner metatarsal tubercle rather small, flattened; outer tubercle smaller, indistinct, scarcely discernible from other granules on sole; inner toes one-half webbed,

other toes three-fourths webbed; discs on fingers much smaller than tympanum, those on toes smaller than those on fingers.

Skin of dorsum, head, sides, arms and legs very smooth with no or only very indistinct corrugation when examined under a lens; chin very finely granulate, breast indistinctly so; venter and under side of thigh strongly granulate; on either side of vent soft tubercles; a groove, immediately behind vent, flanked on either side by several enlarged tubercular granules, arranged somewhat symmetrically.

Color in life: Olive-green on dorsal surface of head and body, on dorsal surface of forearm; a narrow streak on the dorsal surface of upper arm, a narrow band on femur, dorsal surface of tibia and tarsus, and along outer part of foot; ventral and lateral surfaces of body and limbs lemon-yellow; a cream-yellow line on upper lip, very slightly widened below eye, continues along side tending to merge with lateral coloration; no pigment on anterior or posterior face of femur; hands except for outer side of fourth finger, and foot except for outer toe, yellow; anal flap, deep lavender for most of its length. A yellow band crosses anal flap, behind which, on the very edge, is a small lavender area.

Measurements of type and paratype respectively (in mm.): Snout to vent, 36, 35; length of head, 12.5, 11.8; width of head, 12, 11.2; length of tympanum, 2.35, 2.3; length of snout, 5, 4.8; length of eye, 4, 3.8; interorbital width, 4, 3.6; arm, 21, 21; hand, 10.5, 9.6; leg, 51.4, 50; tibia, 17.1, 17; foot and tarsus, 24, 22.5.

Remarks: The paratype agrees in all essential characters, save that the tongue shows a distinct posterior median notch (somewhat indicated in type); the tibiotarsal articulation (heel) reaches a little beyond middle of eye; vomerine fasciculi are a trifle larger, situated between the choanae and reaching neither their anterior nor their posterior levels. The coloration is identical.

The relationship of this form is with *Hyla rufioculis* and *Hyla uranochroa*. The former species is found in the same locality and likewise has a red eye. The calls are different and the males are distinctly smaller; the posterior parts of their thighs are strongly pigmented and in preservation the color is not lavender; the upper arm is not so slender and there is usually a dark line below the light lateral line; the tympanum is smaller, its diameter about a third of the eye length.

The species strongly resembles a species of the genus *Agalychnis* in the characteristic distribution of pigment, the characteristics of

the upper and forearm, the red eye, and the coloration of the body. The eye however has a distinctly horizontal pupil. The species is named for Dr. Ralph Allee, the genial director of the Inter-American Institute of Agriculture at Turrialba, C. R., where I maintained my headquarters for a considerable part of my stay in Costa Rica.

The two specimens were found at a small spring at night by following their calls.

Hyla uranochroa Cope

Figure 49

Hyla uranochroa Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 103-104; pl. 27, fig. 4 (type locality, near Sipurio, Costa Rica); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 38 (no specimens); Boulenger, Catalogue of the Batrachia Salientia s. Ecuadata in the collection of the British Museum, 2nd. ed., 1882, pp. 377-378 (one ♀ specimen, Costa Rica); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, pp. 276-277, Sept. 1901, pl. 70, fig. D (Rio Sucio, La Palma, alt. 1600 meters); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 254; Dunn, Occ. Papers Mus. Zool. Univ. Michigan, No. 151, July 1, 1924, pp. 2-3, pl. 1, figs. 1, 2 (tadpoles and color in Panamanian specimens, La Loma, Panamá).

Diagnosis: The species may be diagnosed by the following characters: greenish in life, becoming blue or bluish lavender in preservative; eyes red in life, becoming whitish or silvery; the tympanum large, more than half diameter of eye; canthus distinct but rounded; vomerine fasciculi small, widely separated, about one third size of choanae; distinct lateral white stripe from tip of snout to groin, widening under eye; chin white, venter yellowish; anal region white except on edges of vent; a narrow pigmented stripe on femur; remainder flesh-color without pigment (yellowish in life); outer fingers about two-fifths webbed; toes approximately four-fifths webbed.

Description of species: (M.C.Z. No. 10249 from La Loma, Panamá.) Head width (14 mm.) greater than length (12.2 mm.); eyes very prominent directed somewhat forward; canthus rostralis distinct, its edge rounded, curving slightly to nostril; upper part of lores sloping precipitately, lower part sloping obliquely to lip, leaving lores somewhat concave; areas about nostrils not distinctly swollen, however a slight depression at the dorsal base of snout is continued indistinctly to between nostrils; tip of snout sharply truncate; seen in profile, snout curves out slightly from nostrils to lip; notch in upper lip scarcely perceptible.

Tympanum large, subcircular, directed outward and somewhat upward, the supratympanic fold covering its upper parts, its diameter (2.5 mm.) more than half length of eye (4.4 mm.), its distance from eye about equal to its own diameter; length of eye

greater than snout length (3.9 mm.); interval between nostrils (3 mm.) less than distance of nostril to eye (3.3 mm.), their distance from median notch on lip less than their distance from eye; width of eyelid (3.3 mm.) less than interorbital width (4.9 mm.); supratympanic fold curving gently from eye over tympanum, then turning down suddenly to behind angle of jaw; choanae moderately large, lateral, separated by a distance equal to approximately four times the width of one choana; vomerine teeth

FIG. 49. *Hyla uranochroa* Cope. M.C.Z. No. 10250; La Loma, Panamá; snout-to-vent length, approximately 36 mm.

in two small, slightly diagonal fasciculi between choanae, but not reaching their posterior level, separated from each other by a distance greater than their distance from choanae; latter larger than openings of Eustachian tubes; tongue subcircular slightly emarginate behind, not or scarcely free behind (males with vocal slits).

Arm and leg laid against body, the knee and elbow do not touch; arm extended forward, the wrist extends considerably beyond tip

of snout; inner toes with a web remnant; outer fingers about two-fifths webbed but web emarginate; discs large, distinctly smaller than the tympanum, but a little larger than discs on toes; inner metacarpal tubercle moderate, its length in the length of inner finger about two and one-half times; palmar tubercle indistinct; granules on palm present but not strongly developed; a tubercular fold on under side of arm.

Leg relatively short, the heel reaching to near front edge of eye; toes slightly less than four-fifths webbed, the web not reaching discs. Inner metacarpal tubercle small, outer almost obsolete; distal subarticular tubercles of two outer fingers usually more or less bifid; legs folded at right angles to the body, the heels overlap 4 mm.; a moderately-distinct inner tarsal fold.

Skin of head and body generally smooth on dorsal surface; laterally (under a lens) it is seen to be roughened by minute elevations each with a minute pit; axillary web absent or very indefinite. Chin smooth anteriorly, granular posteriorly; breast, venter and under side of thigh strongly granular, the granules in anal region especially large and irregular; vent covered with a short wide flap.

Color: Dorsally green in life, yellowish below and on concealed surfaces, the two color separated by a line of enamellike white, beginning on snout, following edge of lip and widening under eye, continued to groin; a sharply defined white band across the anal flap and a considerable white area below the dark colored vent; a more or less distinct white line on outer edge of arm and leg; eye red in life, silvery in preservation. The color of the preserved specimen is purplish-blue above, with lavender on rump and on exposed surface of tibia and foot; under a lens the surface appears frosted with whitish; a frosted band along dorsal surface of femur; remainder of the thigh flesh-color.

Measurements in mm. of Hyla uranochroa Cope

	Type		10249
Snout to vent	40	(39)*	38
Width of head	14	(14.5)	14
Length of head	..	(12.6)	12.2
Diameter of tympanum	..	(2.8)	2.5
Length of eye	..	(4.5)	4.4
Length of snout	..	(4.2)	3.9
Arm	22	(24)	24
Hand	10	(9)	11
Leg	55	(54.5)	58
Tibia	..	(18.4)	20
Foot and tarsus	25	(25)	26

* My measurements of the type specimen in parathenses.

Remarks: The difference between the specimen here described and the type is slight. I have no doubt that the specimen is correctly identified.

This species may be confused with two other red-eyed species that occur in Costa Rica. These are the smaller *Hyla rufioculis* and *Hyla alleei*. From this species *Hyla alleei* may be distinguished by the absence of the enamellike coloration of the anal region and the lateral light stripe, although there is a whitish lateral stripe. The whitish frosting is absent from the dorsal surface. Snout longer than eye, head more flattened; coloration of preserved specimens, reddish lavender. The snout is narrower and more rounded from dorsal profile; eyes very dark in preserved specimens; a groove follows vent.

Hyla rufioculis is distinguished by its smaller size, and more reduced webbing on fingers and toes. Its preserved coloration is brown or grayish brown and there is no white anal spot.

I have examined specimens from Sipurio, Costa Rica and La Loma Panamá. The type, U.S.N.M. No. 30651, is soft but most of the essential characters can still be discerned.

Hyla phaeota Cope

Figure 50

Hyla phaeota Cope, Proc. Acad. Nat. Sci. Philadelphia, 1862, pp. 358-359 (type locality, Turbo, Colombia, J. Cassin, coll. "1 in. 10 lines long"); Werner, Sitzungsb. Akad. Wiss. München, vol. 27, 1897, pp. 215-216 (Panamá); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 1882, p. 402; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 269; Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, p. 413, 420 (Barro Colorado Island) (places *dolomedes* Barbour as a synonym); Nieden, Das Tierreich, Lief. 46, Anuren 1, 1923, p. 261 (Panamá, Colombia, "length to 60 mm."); Gaige, Hartweg and Stuart, Occ. Papers Mus. Zool. Univ. Michigan, No. 357, Oct. 26, 1937, p. 4 (localities in eastern Nicaragua); Taylor, Univ. Kansas Sci. Bull., vol. 28, pt. 1, May, 1942, pp. 80-81, pl. 8, fig. 1, 1a, 1b, 1c (Piedras Negras, Petén, Guatemala); Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, pp. 589-590, pl. 26 (length 56 mm.).

Hyla labialis Peters, Monatsb. Akad. Wiss. Berlin, 1863, p. 463 (Chiriqui, Panamá); *idem, ibid.*, 1873, p. 618 (in synonymy *H. phaeota* Cope); Boulenger, Catalogue, *loc. cit.* p. 397, Bogotá (snout to vent 34 mm.).

Hyla baudinii dolomedes Barbour, Occ. Papers, Mus. Zool. Univ. Michigan, No. 129, Jan. 25, 1923, p. 11 (type locality, Río Esnape, Sambu Valley, Eastern Panamá).

Diagnosis: Large species, ♀ 73 mm., ♂ 50 mm., with a single, very large subgular sac; outer fingers one fourth to one-third webbed; inner with only a small vestige; toes four-fifths webbed, the web touching discs on one side at least on all toes but fourth; tympanum large, its diameter five eights of eye length; tibiotarsal articu-

lation reaches beyond snout; a black spot behind eye passing to side of shoulder, pointed behind, involving entire tympanum; a whitish line on lip continues back and borders the black spot; arms and legs usually barred with darker.

Description of species: Head a little wider than long, rather flattened, its greatest depth at tympanum about 9 mm.; eye moderately prominent, its length 8 mm., slightly less than length of snout;

FIG. 50. *Hyla phaeota* Cope. K.U.M.N.H. No. 25724; Los Diamantes, Costa Rica; actual snout-to-vent length, 72 mm.

canthus rostralis distinct but somewhat rounded on the edge; loreal region distinctly concave, the nostrils lateral, nearer median point on the lip than to eye; close to the most anterior part of the snout, the area about them not or but very slightly swollen; width of an eyelid (6.6 mm.) slightly less than interorbital width (8 mm.); edge of upper lip swollen, thickened, projecting somewhat below eye and tympanum; a heavy fold from corner of eye bends up and over the tympanum reaching to near shoulder; tympanum irregularly shaped the upper edge covered by fold, longer than high, its

length five eights of eye length; tip of snout projecting slightly beyond mouth (1.5 mm.)

Tongue large, subcircular, with a small median emargination posteriorly; choanae moderate, somewhat quadrangular, the width of one in distance between, about 3.4 times; vomerine teeth on two strongly elevated triangular fasciculi almost contiguous, and situated between choanae and not or scarcely reaching a line joining posterior edges of choanae; palatal glands open in a long curving groove closer to the anterior end of palate than to the choanae; 67-68 maxillary teeth, transparent white; 18 premaxillary teeth.

Arms long; fingers with broad terminal discs, about one half as large as tympanum, first smallest, other three subequal, about 4 mm. in width; web remnant between first two fingers, three outer nearly one-fourth webbed, but a narrow web-fringe continues to discs; a large elongate tubercle at inner base of first finger; palmar tubercle large, rather indistinct; large undivided subarticular tubercles; supernumerary tubercles on palm; small irregular tubercles on underside of arm.

Leg very long the tibiotarsal articulation reaching 8 mm. beyond tip of snout; an inner tarsal fold, distinct for its entire length; toes about four-fifths webbed (somewhat less in males); a rounded, flattened inner metatarsal tubercle, its anterior edge raised; subarticular tubercles prominent; a small outer metatarsal tubercle; distinct supernumerary tubercles present; disks on toes not or but slightly smaller than those on fingers; when legs are folded at right angles to body the heels overlap 8 mm.

Skin on back smooth (under lens minutely shagreened). Skin on sides covered with a strong reticulation of grooves dividing the skin into distinct irregular islandlike areas; venter, breast, and under thighs with pavementlike, closely juxtaposed granules; chin less densely granulate; anal opening high on thigh, the short flap laterally narrowed; an indistinct groove follows behind opening.

Measurements in mm.: (Nos. 25724 ♀ and 25720 ♂ Los Diamantes, respectively.) Snout to vent, 72, 52; length of head, 22, 16.7; width of head, 25, 14.8; tympanum length, 5, 4; eye length, 8, 6; eyelid width, 6.6, 4.2; interorbital width, 8, 6; arm and hand, 44.5, 29.5; forearm and hand, 35, 25; leg, 123, 94; tibia, 42, 29.5; tarsus and foot, 55, 40.

Color in life: Above olive-green with dim indications of darker spotting. Later this changed to a yellow green with some dark olive marks; chin lavender, washed slightly with olive; legs banded with dark olive; venter below dirty cream white with a lavender

tinge; underside of limbs somewhat more definitely tinged with lavender; underside of feet and hands purplish lavender.

Color in preservative: Brownish above with trace of a brown band across head and eyelids; on middle of back a more or less regular large chocolate brown mark, and two blackish spots on rump; a black stripe from eye to shoulder involving entirely the brown tympanum; arms and legs barred with dark purplish brown; 6 or 7 bars in tibia; tarsus, foot and hand without marks; below uniform light.

Remarks: This form was described by Cope from a small male specimen, "1 in. 10 lines in length." It has a general appearance similar to *Smilisca baudinii* and has probably been the basis for some of the reports of *Smilisca baudinii* in Costa Rica. Barbour described as new from Panamá, a form, *Hyla baudinii dolomedes,* as follows:

"Similar to true *H. baudinii* of Central America, but with very long hind limbs—longer than Central American individuals which I have seen. The tibiotarsal articulation reaches well beyond the tip of the snout. . . . The form is probably worth full specific recognition."

This has been placed as a synonym of *H. phaeota* by Dunn. The voice of this form was a harsh "squawk-squawk", repeated at intervals of one or two minutes.

Specimens were obtained at Turrialba, Moravia, and at Los Diamantes near Guápiles. They were breeding at the latter station, and recently deposited eggs were found in small rain pools. Females are considerably larger than the males.

Hyla gabbii Cope

Figure 51

Hyla gabbii Cope, Journ. Acad. Nat. Sciences, Philadelphia, ser. 2, vol. 8, 1875, p. 103 (type locality near Sipurio, east coast of Costa Rica, Wm. Gabb coll.); Brocchi, Mission Scientifique au Mexique . . .; Étude des Batraciens de l'Amérique Centrale . . ., livr. 1, 1881, pp. 37-38; Boulenger, Catalogue of the Batrachia Salienta s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 372; Proc. Zool. Soc. London, 1898, p. 478 (Cota Rica ?); Werner, Verh. zool.-bot. Ges. Wien, vol. 46, 1896, p. 355 (Separate, p. 13); (Guatemala. "Irregular large and small yellowish flecks and dark dots"); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 274 (pl. 70, fig. B, type of H. salvini); Werner, Abh. math.-phys. Class. königl. Bayer. Akad. Wiss. München, Bd. 22, Abt. 2?, 1903, p. 351; Nieden, Das Tierreich, Lief. 46, Anura I, June, 1923, p. 252; Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1931, pp. 413-414 (Barro Colorado I., Canal Zone); Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, p. 25 (Ceiba, Honduras).

Hyla salvini Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 372 (figured in Günther, *loc. cit.*, type locality, Cartago and San José, Costa Rica. Here restricted to Cartago.); ? Werner Verh. zool.-bot. Ges. Wien, vol. 46, 1896, p. 350 (page 8 of reprint), (Honduras, see Werner 1903, *loc. cit.*).

Diagnosis: A large *Hyla* (56 mm. snout-to-vent) lacking dark markings on tympanic region and on side of head; a pale labial light line not reaching back to eye; back with several large dark spots, often connecting with a dark band between eyes (all marks occasionally absent as in *"H. salvinii"*); a distinct tarsal fold; toes fully webbed; outer fingers two thirds webbed; skin usually nearly smooth with very small scattered tubercles; palate arched, bearing two elevated, nearly contiguous, transverse fasciculi between choanae; legs with dusky transverse bands.

FIG. 51. *Hyla gabbii* Cope. K.U.M.N.H. No. 28201; San Isidro el General, Costa Rica; actual snout-to-vent length, 49.5 mm.

Description of species: (No. 28201, San Isidro El General.) A moderately large species, the snout-vent length exceeding 50 mm.; head width (17 mm.), a little greater than its length (16 mm.); canthus rounded, the loreal region somewhat concave; area about nostrils a little swollen with a slight depression on base of snout, and continued forward between nostrils; distance of nostril from

eye (4.4 mm.) almost equal to its distance from median labial notch (4.38 mm.); tympanum distinct (2.3 mm. long, 3 mm. high), separated from eye by a distance practically equal to the length of tympanum; eye length (4.8 mm.) greater than its distance from nostril, less than the length of the snout (7.8 mm.); width of an eyelid (4.8 mm.) greater than interorbital width (4.6 mm.); distance between nostrils about 4 mm. In profile the snout slopes forward from the nostrils then becomes rounded to lip, extending beyond lip about .5 mm.

Choanae moderately large, the palate between them a little elevated; vomerine teeth in two transverse fasciculi, each a little smaller than a choana, situated betwen choanae and not reaching their posterior level, closely approximated mesially, separated from choanae by a distance more than half length of a fasciculus; width of choana in distance between choanae about 4.5 times; openings of palatal glands in a sinuous groove, nearer front of palate than to anterior level of choanae; tongue subcircular, somewhat emarginate behind (male with vocal slits); openings of the Eustachian tubes triangular, smaller than choanae.

Arm with wrist extending slightly beyond tip of snout; first and second fingers with only a web remnant, and slight fringes extending to discs; webs on inner side of second finger and on the outer finger reach to near the base of terminal discs; distal subarticular tubercles of two outer fingers not or very indefinitely bifid; inner metacarpal tubercle long, outer palmar tubercle large, usually, at least partially divided; discs on fingers large (2.4 mm.), larger than tympanum, nearly half eye length; a beaded fold along under face of forearm; none or only negligible axillary web.

Leg long, heel reaching 3 mm. beyond tip of snout; toes fully webbed; a distinct sharp-edged tarsal fold that curves toward the heel; inner metatarsal tubercle small, scarcely discernible; subarticular tubercles small; no outer tarsal fold.

Skin generally smooth with fine scattered tubercles; under a lens the skin is finely corrugated, head, especially loreal region, noticeably so; a straight supratympanic fold from eye to above arm covering the upper edge of the tympanum; under surface of arms, chin, breast, venter, and under surface of the thigh, granular, and without a trace of a breast fold; a small anal flap; vent high; a small groove follows vent, flanked on each side by elongate slightly raised areas.

Color: Above brown with an interorbital bar and a series of narrow connecting spots on the back; limbs barred with dusky;

ventral surface of body cream-flesh; under side of feet and outer part of hands dark; sides with a few minute dark flecks, groin finely reticulate with black and white; front and back of thigh with some minute white flecks or reticulations; snout bearing a whitish line along lip border; no dark spots on sides of face.

Measurements in mm.: (K.U.M.N.H. No. 28201, and R.C.T. No. 980 respectively.) Snout to vent, 49.5, 46; width of head, 17, 16.4; length of head, 16, 14.8; length of snout, 7, 6.7; length of eye, 4.8, 4.8; greatest diameter of tympanum, 3, 2.4; arm, 31, 26; hand, 15.8, 13; leg, 82.3, 74; tibia, 31, 27.5; foot and tarsus, 38, 34.2.

Remarks: Three of the specimens are from San Isidro El General on the Pacific slope, at an elevation of approximately 706 meters.

I suspect that the species is confined to relatively low land. It may readily be differentiated from two other large hylids, *Smilisca baudinii* and *Hyla phaeota*, by the presence, in the two latter, of black marks on the temporal region, and the presence usually of spots on the lips. *Smilisca baudinii* has a pair of vocal sacs on the chin in males.

One specimen, No. 53722, from "Río Calabre," Panamá, has the dorsal ground color very light tan, and heavy blackish markings; the dark reticulation on the side being heavy, rather than fine, inclosing rounded light spots; posterior face of the femur dark, with a few cream flecks.

Of two specimens (Michigan Mus. of Zoology No. 70178) from San José, one has the dorsal color grayish without black marks, corresponding to the form described as *Hyla salvini* Boulenger, which with the information at hand is treated as a synonym of *H. gabbii*. The second specimen is dark gray brown and has some indefinite darker markings that are indistinctly visible when the specimen is submerged in water or alcohol.

Specimens were found in bromelias at San Isidro El General.

Hyla wellmanorum sp. nov.

Figure 52

Type: Kansas Univ. Mus. Nat. Hist. No. 30302 ♀; collected at Bataan, Costa Rica (Caribbean drainage); July 20, 1951, E. H. Taylor, coll.

Paratypes: Nos. 30300-30301. Same data. R.C.T. No. 2899, Los Diamantes, 1947, R. C. Taylor, coll.

Diagnosis: Medium-sized frogs (♂ 44 mm. female probably larger) without tarsal fold, outer fingers less than one-fifth webbed, the outer toes two-thirds webbed; skin smooth above; diameter of

tympanum approximately two-thirds diameter of eye; canthus distinct but rounded; tympanum much larger than largest finger pad; heel reaches to nostril.

Description of type: A medium-sized frog (44 mm.), with the width of the head (16 mm.) slightly greater than length (15 mm.); tympanum somewhat irregularly shaped, large, its upper part hidden under a fold arising from eye and curved down behind tympanum, its greatest diameter (3.5 mm.) equal to approximately two thirds length of eye (5 mm.); distance of nostril from eye a little greater

FIG. 52. *Hyla wellmanorum* sp. nov. Type. K.U.M.N.H. No. 30302; Bataan, Costa Rica; actual snout-to-vent length, 44 mm.

than its distance from median notch in upper lip; mesial length of snout (5 mm.) equals eye length; distance between tympanum and eye (2.3 mm.) less than diameter of tympanum; width of an eyelid (4 mm.) less than interorbital distance (5.5 mm.); distance between nostrils 4 mm.; top of head slightly concave in medial occipital region; canthus rounded, curving forward from eye; upper part of loreal region sloping abruptly, lower part sloping obliquely to lip, the loreal region in general concave; areas about nostrils swollen, with a slight depression between, nostrils not terminal.

Choanae large, with a somewhat rectangular shape, the length much greater than width; elevated fasciculi of the vomerine teeth distinctly smaller than choanae, the fasciculi between anterior half of choanae almost contiguous mesially, separated from choanae by a distance half that of a single fasciculus; tongue large, broadly

cordiform, notched behind, only the posterior edge free; (vocal slits present in males).

Arm moderately long, the forearm reaching halfway beyond snout; a small web remnant between outer fingers (one fifth or less webbed); no trace of web between first two fingers; discs much smaller than tympanum; a large metacarpal tubercle; palmar tubercles indistinct; distal subarticular tubercles of fingers usually single, that of outer finger somewhat bifid, a broad thickened ridge on under side of arm.

Leg moderately short, the heel reaching to nostril; when legs are folded at right angles to body the heels overlap approximately 5 mm.; heel and elbow touch when limbs are adpressed; inner toe about one third webbed, outer toes approximately two thirds webbed; a moderately large inner metatarsal tubercle; a small distinct outer tubercle; no distinct tarsal fold, but there is a low thickened ridge more or less discernible.

Skin generally smooth, but under a lens a very fine corrugation is evident; a very slight axillary web present; supratympanic fold may continue a considerable distance on side as a loose skin fold; a low tubercular ridge crossing above vent, more or less distinct; an anal flap very short; vent followed by an indistinct groove bordered by larger flattened tubercles, two of which are white (yellow in life); chin smooth, breast without tubercles; venter and most of space on under surface of thigh granular; indication of a slight breast fold.

Color: In life, light yellowish brown above, growing lighter on sides; below and on concealed surfaces nearly pure white; some pigment on under surface of foot; head with some indefinite spotting above and some fine brownish flecks but lacking spots on sides of snout; a pair of indistinct longitudinal stripes on back connected posteriorly; lip with a very narrow light line bordered on (ventral) edge of upper lip with a fine line of pigment; one subocular eye spot; no black spot from eye across tympanum, but a few fine brown flecks present on side of neck and on limbs; bars on limbs faintly discernible; outer finger and arm, outer toe and tarsus, edged with a narrow white line bordered below with an irregular narrow line of pigment; above vent extending an indefinite distance on thigh, is a transverse white line bordered below by a darker line that can be traced along the thigh nearly to knee; some cream white marks below vent.

Measurements in mm. of Hyla wellmanorum sp. nov.

	Number		
	30302	30300	30301
Snout to vent	44	37	37
Width of head	16	14	14.2
Length of head	15	12.5	13
Length of eye	5	4.4	4.4
Length of snout	5	4.2	4.1
Arm	27	22	21
Leg	72	57	60
Tibia	23	19	19
Foot and tarsus	32	25.2	27

Variation: The two male paratypes differ. One is lighter than type, with a pair of darker brown lines on the back connected across the shoulders. A dark line is present from the eye to the nostril and there are one or two spots between eyes. The dorsal coloration is bordered by a fine line of pigment on the sides and the vocal sac is slightly pigmented with black.

No. 30301 is lavender brown with irregular black marks on back while the lower part of the sides are light, flecked with black. The soles of hands and feet have scattered pigment. A nuptial swelling at the base of the first finger is covered with light brown asperities, the first finger being somewhat opposed to the other fingers. The heels in the paratypes barely reach to the anterior edge of eye.

Relationships: The species somewhat resembles the young of *Smilisca baudinii* but the large skull process is wholly missing. The difference from *phaeota* and *gabbii* is in the shorter leg, lessened webbing of the fingers and toes, and the absence of a definite tarsal fold. I suspect that it is related to the last mentioned species.

Specimens were found on the ground near a rain pool at night, by following the direction of their call. No others were heard.

The species is dedicated to my friends, Dr. and Mrs. Frederick Wellman, who contributed greatly to making my stay at Turrialba a pleasant one, and who assisted greatly in furthering my work.

Hyla cherrei * Cope

Hyla cherrei Cope, Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 195-196 (type locality, Alajuela, Costa Rica, R. Alfaro, coll.).

Hyla cherrii Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1901, p. 264 (Günther's locality, "Rio Alfaro" is probably deduced from the "R. Alfaro" of Cope which is, I believe, intended for the collectors name).

The type of this species cannot be found in the U. S. National Museum collection at the present time and is believed to be lost.

* The spelling of this name should probably be *cherriei* since the species is dedicated to Mr. George K. Cherrie.

None of the specimens of Costa Rican hylids I have been able to examine are referable to the species. In consequence, I quote the original description. The diagnostic characters presented by Cope are: A sharp canthus rostralis, vomerine teeth between the middle of choanae, elongate notched tongue, very large choanae, fingers without web.

Description of species: "Vomerine teeth few, opposite the middle of the very large choanae, at the apex of a ridge which proceeds from the anterior margin of the latter. Ostia pharyngea round, large, but smaller than the choanae. Tongue longer than wide, but little free, and openly notched posteriorly. Tympanic drum distinct, one-half the area of eye, and equal in vertical diameter. Iris dark. Manus almost without web; pes fully palmate. Thumb not opposed. Heel of extended hind limb reaching end of muzzle. Canthus rostralis straight angular, lores vertical. Width of interorbital space 1.5 times the width of an eyelid. External nostrils terminal a little nearer the eye than the diameter of the latter. Muzzle not prominent, vertical in profile. Skin smooth above.

"Head and body above pigmented probably with yellow, in abrupt contrast to the color of the rest of the integument, from which it is separated from the orbit to the sacrum by a narrow white stripe. Colors otherwise uniform straw-color, the limbs pigmented on the exposed surfaces; the humerus and femur not pigmented."

Length of head and body, 26 mm.; length of head to canthus oris, 5 mm.; width of head at canthus oris 8 mm.; length of forelimb, 17 mm.; length of forefoot, 6 mm.; length of hind limb, 45 mm.; length of hind foot, 20 mm.; length of astragalo-calcaneum, 8.5 mm.

No. 253, Alajuela, R. Alfaro.

Remarks: "This small and brightly colored species differs from all others known to me in the combination of characters it presents. The sharp canthus rostralis, anterior vomerine teeth, elongate tongue, large choanae and webless fingers are not found together in any other species. It is dedicated to Mr. Geo. K. Cherrie, of San José, to whom I am indebted for the opportunity of studying the present collection."

Hyla rivularis sp. nov.

Figure 53

Type: K.U.M.N.H. No. 28197. American Cinchona Plantation, (Isla Bonita), eastern slope of Volcán Poás, Costa Rica, elevation 5,500 ft., August 1, 1947, Richard C. Taylor and Edward H. Taylor colls.

Paratype: K.U.M.N.H. Nos. 28196, 28198; R.C.T. Nos. 779, 780, 2063, 2066; same locality and collectors.

Diagnosis: A small species, ♂ 31 mm., ♀ 35 mm., snout-to-vent length. Above generally yellowish olive with or without dorsal markings or network; below with small brownish flecks scattered on posterior part of venter, on sides, and on front, back, and ventral surfaces of femora; canthus sharp, angular; profile of snout strongly cut back under, leaving tip of snout extending beyond lip; heel reaches to eye; tympanum partly (rarely completely) hidden, separated from eye by a distance twice its own diameter.

FIG. 53. *Hyla rivularis* sp. nov. K.U.M.N.H. No. 28197, Type; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 31 mm.

Description of type: Head approximately as wide as body, the snout somewhat narrowed and bluntly pointed; width of head (9.6 mm.) equal its length (9.5 mm.); profile of snout cuts back under nostrils to lip, leaving tip projecting noticeably; canthus rostralis sharp, angular, straight, the upper part of loreal region nearly vertical, the lower part sloping obliquely to lip; the loreal area rather concave behind nostril, which is low (.8 mm. below the canthal level); region about nostrils not swollen; top of head to tip of snout, flat without depressions; tympanum covered with skin, but its outline more or less visible, its diameter approximately 1.3

mm. separated from the eye by a distance of 2.2 mm.; length of eye opening (3.3 mm.) greater than its distance from nostril (3 mm.) and likewise greater than snout length (3.15 mm.); width of an eyelid (2.5 mm.) less than interorbital width (2.9 mm.); a strong fold from eye above tympanum runs back slightly diagonally, then curves down considerably behind jaw angle.

Choanae small, nearly circular, well separated, the diameter of one (.6 mm.) in distance between (2.3 mm.) nearly four times; vomerine teeth in two fasciculi each considerably larger than a choana, situated between posterior part of choanae and extending much behind choanae, the two tooth-rows slightly diagonal; tongue broadly oval, longer than wide, free behind for about one fifth of its length; ample vocal sac visible; the vocal slits in mouth elongate.

Arm moderate, the wrist extends one milimeter beyond snout; a small but distinct axillary fold; first finger not opposed, the distal subarticular tubercles of the first, third, and fourth fingers double or bifid; terminal discs on fingers moderate, the largest, on third finger is 1.6 mm. while that on first is 1 mm. in width; a web vestige between first two fingers; outer fingers one-fifth (or a little less) webbed, the fringe on both sides of digits extending to discs; a thickened continuous somewhat tubercular ridge on under side of arm; inner metacarpal tubercle large, its upper surface covered with nuptial asperities that extend into top of the finger, (the area covered however is much smaller than is usual in hylid forms).

Heel reaches to middle of eye; no inner metatarsal ridge or fold; a suggestion of a thickened outer ridge with an uneven surface; small inner metatarsal tubercle; outer obsolete; inner toes one-third webbed; other toes two-fifths to three-fourths webbed, the fringe continued to discs, which are a little smaller than finger discs; elbow and knee do not, or barely touch; heels (the legs being folded) overlap 2 mm.

Skin smooth on back and sides of head and body, the tibial surface being slightly roughened; chin and breast smooth; belly and under surface of femur with large granules; vent high, the surrounding area fluted, with a dim groove running down behind it, flanked by some enlarged flat tubercles at some distance from vent.

Color: Light, grayish-tan above with darker olive-brown markings; concealed parts of sides and venter, pinkish flesh with yellow on concealed surfaces of limbs, hands and feet; lips gray. Venter, under side of thigh, tarsus, and forearm flecked with light brown; considerable pigment on under side of foot, less on hand.

Measurements of type and paratypes of Hyla rivularis sp. nov.

	28197 ♂	28198 ♂	28196 ♀
Snout to vent	31	30	35
Width of head	9.6	9.7	11
Length of head	9.5	9.5	10.6
Length of eye	3.3	3.3	4
Length of snout	3.15	3.15	3.2
Arm	18.2	19	20
Hand	9	9	9.5
Leg	45.2	43.8	49
Tibia	15.3	14.3	16
Foot and tarsus	22	21	23.2

Variation: Four of the specimens show rather heavy olive dorsal spotting or reticulation. In one specimen the spots are arranged in six transverse irregular blotches, the outer edges of which may be in contact. Another has the larger blotches nearly obsolete with very numerous minute darker olive flecks. One specimen R.C.T. No. 2063 is nearly uniform light gray-tan above with the darker markings all but obsolete, the ventral brown flecks likewise scarcely discernible. The female is lighter, with brown spots on interorbital region, one across the occiput and two lateral irregular longitudinal marks with some smaller brown flecks. Beyond the point where the supratemporal fold turns down, there is an indistinct fold continued to above the arm in most of the specimens. A fold across the breast is evident in the males, barely indicated in the female. The vomerine fasciculi are close together in all, and in some actually contiguous. The snout of the female is slightly depressed between the canthi.

Remarks: Voices of this species had been heard on occasion along a small rivulet filled with high vegetation, but no specimens were taken. One-half day was spent by Mr. Richard Taylor cutting out this vegetation for a distance of some two hundred yards, leaving occasional clumps of plants easy of access. The region was visited at night and with numerous other species, seven specimens of this species were taken in a single weed clump. The female is gravid and while none were found clasping, the males were calling and I suspect that the species was breeding at this time. They were perched on the stems of the plants, about ten feet from the water at a height of five or six feet.

Hyla angustilineata sp. nov.

Figure 54

Type: United States National Museum No. 75060, La Palma, Costa Rica, M. Valerio coll.

Paratypes: U.S.N.M. No. 75061, 75065, same data.

Diagnosis: A small species (30 mm. ♂) with a rather pointed snout, the canthus rounding; a narrow dorsolateral light line from eye, above tympanum to groin; a darker lateral stripe beginning behind eye, extending to groin; chin, throat, venter, and front, ventral and posterior surfaces of thigh strongly spotted with dark brown; fingers without or with only a vestige of a web; first toe with a web vestige; other toes about one third to two fifths webbed; skin smooth; vomerine teeth largely behind posterior level of choanae;

FIG. 54. *Hyla angustilineata* sp. nov. Type. U.S.N.M. No. 760; La Palma, C.R.; snout-to-vent, 30 mm.

deep blackish brown above, uniform or with some obscure markings.

Description of type: Head not wider than body, snout rather pointed. Width of head (11.2 mm.) approximately equals its length (11.1 mm.); tympanum distinct, its upper edge covered with a fold from eye, its diameter (1.5 mm.) contained approximately two and one-half times in the length of the eye (3.8 mm.); distance between tympanum and eye 2 mm.; distance between eye and nostril 27 mm., the length of the snout being 3.9 mm., approximately equal to length of eye; canthus moderately distinct, rounded, the loreal

region sloping obliquely to lip, not or scarcely concave; areas about nostrils slightly swollen but no depression between them; anterior to nostril the snout slopes forward and downward slightly then continues curving from this point to lip; snout thus rounded in profile projecting about 1.3 mm. beyond the mouth; width of an eyelid (2.7 mm.) less than interorbital width (3.1 mm.).

Choanae small, circular, the distance between them (2.9 mm.) from five to six times diameter of one choana; vomerine teeth in two compact fasciculi, narrowly separated from each other, and from choanae by half width of one, situated between but for the most part behind posterior level of choanae, each double the size of a choana; tongue broader than long, notched behind, with only edge free behind; a pair of elongate vocal slits extending rather far forward along side of tongue; arm short, the wrist reaching tip of snout; none or only a very slight axillary fold.

Fingers lacking web or outer with only a trace of a web; distal subarticular tubercles of outer fingers bifid or double; a rather indistinct inner metacarpal tubercle; this together with much of the base of first finger covered with a nuptial swelling, covered with brown horny asperities; penultimate joint likewise more than one third covered; palmar tubercle tripartite or diffuse; outer fingers long, first short with a small disc; discs on outer fingers (1.5 mm.) as large as tympanum; no fold or tubercles under forearm.

Leg rather long, the heel reaching tip of snout; elbow and knee touch when adpressed; heels when legs are folded at right angles to body, overlap 3 mm.; no distinct tarsal fold; a trace of web between the first two toes; second and third toes with web extending one third length of second; three outer toes one-half and two-fifths webbed, inner edges of digits practically lacking a fringe; inner metatarsal tubercle small, outer nearly obsolete; discs a little smaller than those on fingers.

Skin smooth above, without corrugation or tuberculation when seen under a lens; sides of body and limbs smooth; chin with some granulation; breast, venter, and mesial part of thighs heavily granular; vent opening near ventral level of thighs; the anal flap thickened, followed by an indistinct groove.

Color: In life, color unknown; in preservative deep blackish brown with a faint suggestion of darker marking when specimen is submerged in liquid; a broad lighter brown stripe from eye to groin, separated from the dorsal coloration by a very narrow cream or yellow line extending from eye to groin; side of head a little lighter brown, with some darker and lighter areas along lip, and

an indefinite lighter area immediately below the posterior part of eye; all ventral and concealed surfaces of side and limbs including underside of hand and foot, yellowish flesh, strongly flecked and spotted with brown; dorsal part of thigh dark, the front and back with large irregular dark spots; limbs not or obscurely banded; arm bearing several small black flecks, as do tibia and tarsus, but these probably are not remnants of leg bands; digital discs lighter in color.

Measurements of type (75060) and paratype (75065) respectively in mm.: Snout to vent, 30, 29.2; length of head, 11.2, 11.4; width of head, 11.1, 11.2; length of eye, 3.8, 3.8; length of tympanum, 1.5, 1.5; length of snout, 3.9, 4; arm, 17, 17; hand, 9, 8; leg, 47, 45.2; tibia, 17, 16; foot and tarsus, 22, 21.

Variation: The second paratype is young (21 mm. snout to vent). The dorsolateral line and the granules on chin and breast are somewhat indistinct.

Remarks: The species need not be confused with other species in Costa Rica. *Hyla cherrei* has a dorsolateral stripe and the webless fingers of this form but the vomerine teeth are opposite the middle of the large choanae; tympanum half of eye, toes fully webbed, and the humerus and femur are unpigmented, as is the venter.

Hyla moesta, a very poorly described species, has the ventral surfaces black spotted, but it differs in having webbed fingers, tympanum one fourth of eye, head short and wide, brownish black above, sides and the front and back of femora deep black; white spots in axilla and groin; minute white dots on front and back of femur; limbs and hand (except first finger) black.

Hyla nigripes Cope

Hyla nigripes Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, 1875, pp. 104-105, pl. 23, fig. 7 (type locality, 5000 to 7000 ft. elevation on Pico Blanco, Costa Rica) (2 cotypes U. S. N. M. Nos. 30685, 30686); Brocchi, Étude des Batraciens de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 1, 1881, p. 38; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 394; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 278; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 253.

Diagnosis: This form may be diagnosed as follows: rather elongate oval head, with the canthus rostralis curving forward to nostril ("concave"), shallowly concave in loreal region; nostril a little closer to eye than to median point on edge of upper lip; loreal region very oblique; tympanum small, its diameter about one half eye length; skin smooth, fingers about half webbed, the toes four

fifths or more webbed, the web not quite reaching end of the penultimate joint; heel to beyond the tip of snout. Color uniform brown or brown with darker dorsal markings; sides darker than back; feet, dark; posterior face of femur blackish unspotted; sides of throat dusted black; front of femur pigmented; groin with numerous whitish spots in a dark recticulum.

Description of species: Head rather oval, nostrils equidistant from eye and median edge of lip; a slight depression present on snout behind level of nostrils; tympanum medium its diameter (2.3 mm.) almost half length of eye (4.5 mm.) ("orbits large and from four to five times the area of the tympanum"); length of eye distinctly less than length of snout (5 mm.); width of an eyelid less than the interorbital distance; loreal region very shallowly concave sloping very obliquely to edge of lip. Choanae considerably larger than vomerine tooth fascicles which are separated mesially and lie between choanae not reaching behind their posterior level.

Arm moderate; between first two fingers about one fifth webbed; outer fingers about half webbed; ("Digital dilations are moderate, the web of the fingers extending about half-way to the end of the longest, notched deeper than the line of the penultimate phalange.")

Leg long, the heel reaching beyond tip of snout; when limbs are pressed on sides, knee and elbow overlap some distance.

Skin smooth above and on sides; chin, breast and venter, as well as under side of femur granular or areolate.

Color: Above dark brown (probably olive in life) the limbs and feet blackish; sides, from ear back, blackish brown; numerous small cream spots in darker blackish reticulum; front of thigh pigmented; posterior surface of thigh black unspotted; no spots elsewhere; lip brown; venter whitish, sides of throat dusted brown; limbs dimly barred.

Measurements of cotype of Hyla nigripes: (presumably No. 23806. Measurements in parentheses are my measurements taken in 1950.) Snout to vent, 39 (37); length of head, 11 (12); width of head, 13 (13); length of snout, 5 (4.9); tympanum length, — (2.3); eye length, — (4.5); arm, 24 (23); hand, 10 (10); leg, 65 (63.5); tibia, — (21); foot, 16 (16); foot and tarsus, — (26).

Remarks: I have seen certain specimens from Costa Rica identified as being of this species which differ in certain characters and likewise differ somewhat among themselves. While the material is somewhat faded, none of the specimens show the dark coloration one is lead to expect from the type description. It may be that the

dark is intensified in the type due to the very heavy rainfall of the type locality. Until the species is rediscovered on Pico Blanco, there will be a slight doubt as to whether or not the museum specimens referred to the species are correctly identified.

Hyla moesta Cope

Hyla punctariola moesta Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 106 (type-locality, Cordilleras [of Pico Blanco] 5000 to 7000 feet, Costa Rica, Wm. Gabb, coll.); U. S. Nat. Mus. Bull. 32, 1887, p. 15.

Hyla punctariola Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata. . . . 2nd ed. 1882, p. 401 (*part.*) Günther, Biologia Centrali-Americana, Reptilia and Batrachia, Sept. 1901, p. 282 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 256-257 (*part.*).
(See comments under *Hyla monticola*).

The very brief description given by Cope follows:

"The fingers are not entirely free, but a web extends between the outer two to the middle of the first phalange. The area of the tympanum in the same is one-fourth that of the orbit. The head is short and wide, and the heel extends nearly or quite to the end of the muzzle."

"Above blackish-brown, sides and femora, except above and below, deep black. Some white spots on sides behind axillae, and some small yellow ones near groin. A few minute white points on front and back of femur, and upper surfaces of feet. Otherwise limbs and hands, except the thumb, are black. Lower surfaces thickly black spotted except on breast and tibia, where the white predominates. One specimen." Length 37 mm.

Hyla monticola Cope

Hyla punctariola monticola Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875 p. 106 (type-locality-"Cordilleras at from 5000 to 7000 feet" elevation; slopes of Pico Blanco, Costa Rica. Wm. Gabb, coll.); and U. S. Nat. Mus. Bull. 32, 1887, p. 15.

Hyla punctariola Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata. . . . 1882, p. 401 (*part.*); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 282 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 256-257 (*part.*).

Hyla punctariola is apparently an eleutherodactylid. Cope was not aware of this and associated three small hylid frogs with that form as subspecies although stating his suspicion that these three were true species. The meager descriptions of the specimens are due, I suspect, to the poor condition of the specimens. One of them *pictipes* is still extant. The other two *moesta* and *monticola* cannot be found in the collection of the National Museum at the present time. I have not been able to recognize these species in any of the material collected or in specimens examined in museums.

The brief data given by Cope of *monticola* follow:

"Color light grayish-brown with large dark-brown spots forming transverse bars, one between the eyes, one in front of the scapulae, one behind the scapulae, and one at the sacrum. Below unspotted white. Limbs with light-brown surfaces above; concealed surfaces pale, unspotted. No inguinal spots; a few specks of brown on sides. Length of head and body .037m."

One specimen only; "fingers not entirely free, but a web extends between the outer two to the middle of the first phalange. The area of the tympanum in the same, is one-fourth that of the orbit. The head is short and wide, and the heel extends nearly or quite to the end of the muzzle."

Hyla boulengeri (Cope)

Figure 55

Scytopsis boulengeri Cope, U. S. Nat. Mus. Bull. No. 32, 1887, pp. 12-13 (type locality, Nicaragua; type U.S.N.M. No. 13974, MacNeil coll.).

Hyla boulengeri Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1901, June, pp. 267-268; Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, pp. 339-340, pl. 17, figs. 1, 2 (Kanawa, Sioux Plantation on Río Grande, Nicaragua. Contains certain corrections of the type description.); Nieden, Das Tierreich, Lief. 46, Anura I, June 1923, pp. 251-252; Dunn, Occ. papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, p. 413 (Panamá); and *ibid.* vol. 8, June 7, 1933, p. 62 (Key); Gaige, Hartweg, and Stuart, Occ. Papers, Mus. Zool. Univ. Michigan, No. 357, Oct. 27, 1937, p. 4 [Panamá; Venezuela, British Guiana, and Nicaragua (Río Mico and Recero)].

?*Hyla lancasteri* Barbour, Proc. New England Zool. Club, vol. 10, Mar. 2, 1928, p. 31, pl. 4, fig. 2. (Placed in synonymy by Dunn, *loc. cit.*).

Diagnosis: Snout low, flattened, elongate; canthus indistinct or absent; eye relatively small, its length equal to three fourths its distance from nostril; choanae very large, the diameter of one equals distance between them. Diameter of tympanum three fourths length of eye; web between first two toes consists of a fringe on second toe.

Description of the species: (K.U.M.N.H. No. 24741. Turrialba, Costa Rica.) Head a little broader than body, its length slightly greater than width; snout flattened, low, without canthus rostralis; area about nostrils raised and swollen; loreal region obliquely sloping; eye relatively small, its length equalling three fourths of its distance from the nostril; interorbital width about equal to width of an eyelid or minutely greater; tympanum large, slightly longer than high, its greatest diameter three fourths of length of eye. Choanae relatively very large, the diameter of one equal or greater than distance between them; vomerine teeth entirely between choanae on two transverse, elevated groups of 8 teeth, touching edge of choanae and practically contiguous mesially; palatal

FIG. 55. *Hyla boulengeri* (Cope). K.U.M.N.H. No. 24741; Turrialba, Costa Rica; actual snout-to-vent length, 45 mm.

glands opening into a straight transverse groove; maxillary-premaxillary teeth 93-96; tongue subcircular, a little longer than wide, slightly notched behind, free behind for about one eighth of its length. Openings of vocal sacs lateral to tongue, widely separated from edge of jaw.

Arms short, fingers practically without trace of web; three outer digits with broad, truncate, terminal discs of nearly equal width, that of inner finger about three fourths the size of those on outer fingers; an elongate tubercle at base of first finger and a large yellow gland on inner and upper surface of its base, nuptial rugosities however not present; three distinct palmar tubercles; palm covered with small irregular tubercles; subarticular tubercles moderately distinct, none bifid.

Leg moderately long, tibiotarsal joint reaching forward to a point halfway between eye and nostril; when legs are folded at right angles to body, heels overlap 7 mm.; toes with broad terminal discs,

that of inner toe practically as wide as those of outer four; first toe practically free from web; inner toes more than three fourths webbed, web reaching the discs on outer side of second and inner side of fifth; one and one-half joints of fourth toe free, inner edge of second toe with a broad fringe; inner metatarsal tubercle rounded, outer a little smaller but equally elevated; an indistinct row of outer tarsal tubercles; supernumerary tubercles on soles; subarticular tubercles distinct and moderately prominent.

Skin with numerous warts and tubercles; three black tubercles on snout arranged in a triangle; indistinct black tubercles between orbits, a fold above tympanum continuing above arm, and a small fold from below tympanum running back a short distance; back and sides with indistinct tubercles, many capped with a small pearl point; anal opening high, the flap bearing two tubercles; a narrow groove extended down from vent; venter strongly granular; chin and throat with smaller, less distinct granules; a row of three or four large tubercles below on lower lip; pearl-capped tubercles on tibia and tarsus.

Color: Dark brownish on head and dorsum, the tubercles dark or black, usually with pearly tubercular tips; venter yellowish; groin yellowish brown, with a larger black spot and some smaller spots; femur strongly barred with black, especially evident on posterior side of femur; tibia less strongly marked except on under surface where the dark marks are distinct; a few scattered blackish dots on under side of femur; foot mottled dark and light; brownish on under surface of foot and toes.

Measurements in mm.: Snout to vent, 45; length of head, 16; width of head, 14.5; tympanum length, 3; arm, 23; leg, 66; tibia, 24; foot and tarsus, 30.

Remarks: A specimen of *Hyla boulengeri* was collected by me the night of June 24, 1947 at Turrialba, Costa Rica. It was discovered by tracing a call in a large clump of papyrus on the edge of an artificial pond on the grounds of the Inter-American Institute of Agriculture. No other specimens were seen, or their calls heard by us during our sojourn in the country in 1947.

I have examined the specimen described by Barbour (Harvard M.C.Z. No. 13062 from Peralta, Costa Rica, elev. 500 meters) as *Hyla lancasteri.* It is based on a newly transformed specimen that is badly preserved. That it is related to *Hyla boulengeri* is evidenced by the free inner toe, large dark spot in the groin, and the dark bars on thigh, especially those on the front. There is webbing on hands and feet despite the fact that the illustration, *loc. cit.*, seemingly

depicts a specimen lacking a web between the toes. There is doubt that it is identical with *Hyla boulengeri*.

I have examined Harvard M.C.Z. No. 25984 from "Falcon State", Venezuela, which purports to be this species. The specimen however differs in having the skin of the snout smooth; a well-defined dark triangular mark between the eyes, edged with white; groin yellow; lower lip white-edged bordered by a narrow black line; dark marks above and below anal opening; the diameter of tympanum 1⅓ times in length of eye; choanae about ½ size of that in the Costa Rican specimen; no tarsal fold present; belly granular; chin smooth. It is doubtful that this specimen belongs in this species.

Hyla elaeochroa Cope

Figure 56

Hyla elaeochroa Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 105, pl. 26, fig. 3 (type locality "east foot of mountains near Sipurio, Costa Rica").

Hyla quinquevittata Cope, Proc. Amer. Phil. Soc., vol. 23, 1886, p. 273 (type locality Nicaragua, Bransford collector, type U.S.N.M. No. 14187); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1901, pp. 268-269 (no specimen); Atkinson, Ohio Naturalist, vol. 7, p. 152 (*fide* Noble *loc. cit.*); Noble, Bull. Amer. Mus. Nat. Hist., 1918, vol. 38, pp. 340-341 (specimens from Tuli Creek and Cukra, Nicaragua); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 251.

Hyla rubra (*part.*) Dunn and Emlen, Acad. Nat. Sci. Philadelphia, 1932, vol. 84, p. 25 (synonymizes *quinque-vittata* Cope, with *Hyla rubra*).

Diagnosis: Medium small frogs reaching a snout-vent length of 34.5 mm. in females; canthus rostralis practically absent; choanae large; fingers with web remnants; first toe practically free from web; outer toes more than two-thirds webbed; heel reaches approximately to anterior edge of eye; no light spotting on thighs or lateral light stripes present; no trace of a tarsal fold.

Description of species: Head somewhat triangular; eye length 3.2 to 3.5 of length of snout, usually reaching to anterior edge of nostril; diameter of tympanum in eye length, 1.5 times; interorbital width (about 3 mm.) approximately equivalent to width of an eyelid; distance between nostrils equal to their distance from median point on edge of lip; head length (11 mm.) a little longer than width (10 mm.); canthus practically absent, snout long; eye dark; choanae large, separated from each other by a space equal to distance between nostrils or 2⅓ times greatest diameter of a choana; vomerine teeth in two ridged fasciculi each much less than area of choana. Tongue large, not or scarcely free behind; openings of vocal sacs elongate; externally the sac shows ample folds and is limited by the transverse breast fold.

Skin above in most specimens minutely rugose, the small rugosities usually visible without lens (however some light-colored, unlined specimens show relatively smooth skin and the minute pustules are visible only with a lens); venter, as far forward as the curving skin-fold on breast, strongly granular as is also greater part of under surface of thighs and area below anal opening on posterior thigh surface; neither distinct glandular row of tubercles on forearm nor any trace of an inner or outer tarsal fold.

A trace of web between all fingers, and a ridge or fringe continues along sides of fingers for some distance; none of the sub-

FIG. 56. *Hyla elaeochroa* Cope. K.U.M.N.H. No. 24642; Turrialba, Costa Rica; actual snout-to-vent length, 34 mm.

articular tubercles divided; tubercle on base of first finger moderately large and flat, covered partially with light-colored nuptial asperities, as is upper surface of basal part of first digit. First finger much shorter than second with a smaller disc; discs of outer fingers (1.65 mm. wide) distinctly broader than tympanum; a small axillary web.

Foot with outer toes more than two-thirds webbed, but web nowhere reaching near discs; inner toe nearly free of web; a flat inner and an indistinct small outer tubercle. When leg is laid forward, heel (tibiotarsal articulation) reaches some point on eye, or, chiefly in females, slightly in advance of eye; heels overlap about

3 mm.; length of body in the series very uniform—males measuring from 30-32.4 mm., females from 32-34.5 mm.; females differ a little from males in having eye and tympanum slightly greater in size proportionally.

Color: In life ground color yellowish or olive-green with an indefinite dark triangular mark usually visible on head and occiput, the apex directed backwards; upper lip light without markings; legs barred; venter and chin without pigment, yellowish or whitish; dark pigment under thigh, tarsus, hand and foot; axilla yellowish or greenish yellow without dark pigment; some dark markings are usually present, and these consist of a pair of dorsolateral marks often accompanied by a median dark mark or stripe; frequently there are two longitudinal markings dorsolaterally.

Measurements in mm.: (of a female.) Snout to vent, 34.5; tympanum, 1.87; eye, 3.6; snout, 5.2; interorbital width, 3.2; head width, 11.4; head length, 12.8; leg, 54.5; arm, 21.5.

Remarks: A large series of a small species of frog taken at Turrialba, Costa Rica, is associated with *elaeochroa* since they agree with the description and the type of this form better than with any other known species. One might imagine that a comparison with the type would settle the matter beyond question. However, the type is not in good condition, and some of the features are no longer distinguishable. Dr. G. K. Noble (*loc. cit.*) calls attention to some apparent discrepancies between the original description and the type.

Certain specimens, presumably of the species at hand, taken in Panamá by Dr. Emmett Reid Dunn, have been referred to *Hyla rubra,* but the characters of this latter species, larger size (reported 39-46 mm.), lateral light stripes with dark longitudinal markings and light spotting on front and back of thighs as well as certain other features, preclude the association of my specimens under that name. Whether the true *Hyla rubra* occurs in Panamá I cannot say.

The relationship of the species is with the small *Hyla staufferi* Cope described from Orizaba, Mexico. The enlarged choanae, reduction of the webbing of the hand, the almost complete freedom of the inner toe from web, the linear dorsal markings and triangular occipital marking, the elongation of the snout, the inconspicuous or absent canthus rostralis, the absence of both inner and outer tarsal folds, the absence of a fold or distinct tubercles on the forearm, the enlarged digital discs and the very prominent double palmar tubercle all point to close relationship.

Hyla staufferi has a wide distribution through southern Mexico. It has been reported in Honduras by Dunn and Emlen as *Hyla culex* Dunn and Emlen (*fide* Gaige and Stuart); from Nicaragua by Cope and presumably from Panamá, by Dunn as *Hyla altae* Dunn.

Hyla boulengeri, a much larger species that may be related has relatively much larger choanae, has the low elongate snout, the reduction of the finger web, and the inner toe practically free.

Hyla elaeochroa is represented in the collection by about 80 specimens. They were collected on a number of nights in June, July and August, 1947 and 1951. A few clasping pairs were taken. Females are few and may be readily recognized by their larger size, and being somewhat distended with eggs. The variation in pattern is considerable, the specimens varying from the typical five-lined pattern with the median dorsal line terminating in the triangular mark on the head, to individuals that show no trace of pattern whatsoever but are uniformly olive green or yellow green to gray above. The specimens lacking pattern were taken at night, but if these were examined the following day many of them would have developed the lineation. Later in the day the pattern might be very dark. Since most of my specimens were preserved shortly after capture at night, only a few show the pattern. There is no suggestion in the living specimens of reddish coloration, white spotting on the thighs or dorsolateral light stripes, all characters of *Hyla rubra.* The upper lip is slightly lighter than loreal region but there is no white or cream spot below eye; the dark line between nostril and eye continued back as a lateral line, is usually evident. The dorsolateral lines arise from back of eyelid, and the median line usually consists of a few median spots and a discrete triangular dark area, the apex of which is on the occiput. The expected marking on the thigh and legs is a single bar on thigh and three bars on the tibia. Pigment is absent from the ventral surfaces of the venter and chin, but part of the under surface of thigh, tarsus, hand and foot have considerable pigment. The axillary region is unpigmented.

Hyla staufferi Cope

Hyla staufferi [*] Cope, Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 193 (type locality, Orizaba, Veracruz, "Obtained by Professor T. Sumichrast" probably a typographical error for F. Sumichrast); Brocchi, Mission Scientifique au Mexique et dans l'Amérique Centrale; Études des Reptiles de l'Amérique

[*] In the type description of *Hyla staufferi* there is seemingly an error, the result of a *lapsus:*

The statement "vomerine teeth in fasciculi between nares, which are a little larger than choanae" obviously should read "vomerine teeth in fasciculi between choanae, which are a little larger than the fasciculi."

Centrale, livr. 1, 1881, p. 36, pl. 14, fig. 3, 3a (Tapana, Tehuantepec, Mex., illustration good); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata, 2nd ed., 1882, pp. 400-401 (Mexico); Kellogg, U. S. Nat. Mus. Bull. No. 160, pp. 173-174 (Orizaba and Portrero, Veracruz); Smith and Taylor, U. S. Nat. Mus. Bull. No. 194, p. 88 (many localities in Mexico).

Hyla eximia staufferi Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 14.

Hyla eximia (*part.*) Günther, Biologia Centrali-Americana; Reptilia and Batrachia, June 1901, pp. 261-262; Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 245 (*part.*).

Hyla culex Dunn and Emlen, Proc. Acad. Nat. Sci. Philadelphia, vol. 84, 1932, pp. 24-25 (Tela, Honduras); Gaige, Carnegie Inst. Washington, Publ. No. 457, 1936, p. 293.

Hyla altae Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 8, 1933, pp. 61-62 (type locality, Summit, Canal Zone).

Diagnosis: Small frogs, (female 30 mm., male 27 mm.) with a low elongate snout, lacking a distinct canthus rostralis, the snout sloping very obliquely to lip in loreal region; diameter of tympanum one third to (more usually) one half eye length; toes, except inner, one-half to three-fifths webbed, bearing large terminal pads; fingers free, skin smooth or slightly tubercular; no inner or outer tarsal fold; choanae usually large, the vomerine tooth fasciculi between them, but smaller than choanae; usually a triangular interorbital bar or spot; with or without two to five irregular longitudinal dark stripes.

Description of species: Head oval, approximately as wide as body (except in gravid females); eye relatively small, much shorter than snout; snout flattened, the canthi very indistinct or absent, the loreal region but slightly concave, sloping obliquely to lip; area about nostril somewhat swollen with a slight, longitudinal depression between nostrils; anterior to nostrils, snout forms a somewhat pointed "nose", projecting beyond lip 1.3 mm.; tympanum distinct, directed slightly upward, its length 1.3 mm., its height 1.5 mm., separated from eye by a distance equal to its length; length of eye opening (2.75 mm.), about equal to its distance from nostril (2.7 mm.), shorter than length of snout (3.5 mm.); supratympanic fold indistinct; width of an eyelid (1.9 mm.) distinctly less than interorbital distance (2.7 mm.); distance between nostrils 1.85 mm.

Tongue rounding, a little longer than wide, not or scarcely emarginate behind, free only on posterior edge for one eighth its length; choanae large, the distance between them equivalent to 2.1 times the diameter of one; vomerine teeth in two small fasciculi between the middle of choanae, not reaching their posterior level, separated from choanae by a distance equal to length of one fasciculus and from each other by less than half this distance; choanae larger than openings of Eustachian tubes; vocal slits much elongated; a very large vocal sac extends from gular region to breast, where it is

limited by a distinct breast fold in males (the fold less distinct in females).

Arms short, the wrist not reaching tip of snout; a small axillary web; fingers unwebbed, their edges with very low ridges; digital discs large, increasing in size to third, which is 1.4 mm. in greatest width; inner metacarpal tubercles rather indistinct, at lower base of first finger; dorsal surface of first finger with a nuptial gland not reaching to end of the antepenultimate joint, without horny tubercles; palmar tubercle bifid, strongly defined; subarticular tubercles all single; glandular or tubercular ridge on under surface of arm all but obsolete.

Heel reaches middle of eye; when legs are folded at right angles to the body they overlap strongly (3.5 mm.), knee and elbow do not touch; between first and second toes the web greatly reduced forming a fringe on inner side of second; other toes from one half to three-fifths webbed, the web reaching to near disc of outer toe; no inner or outer tarsal fold; a small inner metatarsal tubercle, a smaller but distinct outer; largest toe discs equal to largest discs on fingers; supernumerary granules on foot and hand indistinct or obsolete.

Skin smooth with a few scattered small tubercles on loreal region, sides of body and back; arms and legs smooth; chin and breast smooth; venter and posterior part of the ventral face of femur granular; vent high without tubercles or granules in area.

Color: Above brownish, a little lighter on snout; triangular interorbital mark scarcely discernible; a dim dark streak from nostril to eye; a pair of curving lines from eyes across shoulders continued indistinctly on sides to sacrum; below this another indistinct darker irregular line on dorsolateral region; a few scattered small dark marks on rump; light line on lip with slight pigment, continuing on to side above arm; ventral surface of body and under surfaces of limbs creamy white or yellowish, bars on dorsal surface of tibia indistinct, those on femur obsolete; under side of hands and feet, except discs, pigmented.

Measurements in mm.: Snout to vent, 27; width of head, 8.9; length of head, 8.7; length of snout, 3.5; greatest diameter of tympanum, 1.6; length of eye, 2.75; arm, 14.2; hand, 7.2; leg, 36; tibia, 12.6; foot and tarsus, 16.5.

Remarks: Mrs. Helen T. Gaige, *loc. cit.*, has pointed out that *Hyla staufferi* is not closely related to *Hyla eximia*, but shows a close resemblance to *Hyla culex* and *Hyla altae*. She suggests that possibly Brocchi's figure, *loc. cit.*, may be *culex*.

In large series of specimens in the EHT-HMS collection of *staufferi,* one of the common species of Veracruz, specimens matching the figure given by Brocchi are common, and likewise specimens matching the descriptions of *culex* and *altae.*

The color pattern is extremely changeable. Specimens taken in the daytime are dark, strongly lined, with the interorbital bar strongly marked, and the barring on the femur strong on the dorsal surface, and extending somewhat on to the anterior face. Specimens taken at night are very light, often nearly yellow, with scarcely any evidence of marks. If these are preserved at night they retain the light color; if they are kept alive on into the following day, part or much of the normal pigmentation may reappear.

The presumed differences between *Hyla culex* and *Hyla staufferi* seem to be in the relative size of the tympanum and the eye. The statement "tympanum ⅓ eye" leaves one in doubt as to whether the diameters or areas are being compared. The tympani of the greater number of specimens have their greatest diameter closely approaching one half the length of the eye opening; a few are a little less than this, approaching one third the length. I have not been able to examine the type of *culex,* but paratype No. 20262 in the Museum of Comparative Zoology is *Hyla staufferi* Cope. I have examined the type of *Hyla altae* in Harvard.

The inclusion of *Hyla staufferi* in the Costa Rican fauna is based on its presence in Honduras and Mexico and its presence in the Isthmus of Panamá. It is presumed that its lowland distribution is not discontinuous.

The type, U.S.N.M. No. 15317, has lost most of the original markings. The measurements are snout to vent, 25.5 mm.; transverse diameter of tympanum, 1.3 mm.; transverse diameter of eye, 2.4; eye to nostril, 3; head width, 8.5.

Hyla moraviaensis sp. nov.

Figure 57

Type: Kansas Univ. Mus. Nat. Hist. No. 30284, Moravia, Costa Rica (Caribbean drainage), Aug. 16, 1951, Edward H. Taylor, coll.

Paratypes: Nos. 30283, 30285, 30286, same locality, date, and collector.

Diagnosis: A small species (32 mm. ♂) with top of head convex, the eyes especially prominent; a tarsal fold; thighs strongly banded with black; arms, legs, and feet banded; brown above, strongly spotted; black on back and sides; venter largely pure white.

Description of type: Small frog (snout to vent 32 mm.); top of head convex rather than flat, its highest elevation between posterior part of orbits; eyes prominent, extending beyond outline of head; width of head at tympanum (11.8 mm.) greater than head length (9.2 mm.); width of head through eyes 12.5 mm.; diameter of tympanum (2 mm.) slightly greater than its distance from eye; length of eye 3.9 mm.; eye to nostril 2.6 mm.; median length of snout 2 mm.; canthus rostralis wanting; loreal region sloping gradually to lip; width of an eyelid (4 mm.) greater than interorbital width (3.5 mm.); area about nostrils slightly swollen, with a broad

FIG. 57. *Hyla moraviaensis* sp. nov. Type. K.U. M.N.H. No. 30284; Moravia, Costa Rica; snout-to-vent length, 32 mm.

shallow depression between; tympanum directed partly outward and upward, the edges somewhat elevated; a narrow supratympanic fold, from eye, curving across top of tympanum to a point above arm; a very indistinct notch on upper lip; nostril nearly equidistant from eye and from median upper lip notch; tongue broadly oval, notched or indented behind, free for about one fifth its length; choanae rather small; vomerine teeth in two rounded elevated fasciculi between posterior part of choanae, separated from choanae and each other by equal distances; vocal slits elongate, the vocal sac indicated externally by folds.

Arm relatively long, with half of forearm extending beyond snout; terminal discs on fingers, except first, distinctly wider than digits, but smaller than tympanum; a web fringe between first and second fingers; outer toes a little more than one third webbed; distal sub-

articular pads of inner and outer fingers double; basal part of first fingers with a nuptial swelling, covered with minute blackish spines; a prominent palmar tubercle, bifid anteriorly; a slight fringe on outer finger and a row of rather indistinct tubercles on lower edge of arm.

Leg rather short, the heel reaching to the middle of eye; when legs are folded at right angles to body they touch or barely overlap; inner metatarsal tubercle distinct, the anterior edge free; inner tubercle not distinguishable; a distinct inner tarsal fold or ridge; terminal discs wider than digits, but on neither hand or foot are they as large as tympanum; toes more than three fourths webbed; a slight fold on outer edge of fifth toe continued as an irregular tubercular row on outer edge of tarsus.

Skin generally smooth with scattered soft pustules, indistinct or lacking on sides; chin and breast smooth, venter and under parts of thighs granular, those on thighs the larger; distinct tubercles on under side of hands and feet other than the subarticular tubercles; anal opening high, followed by an indistinct groove bordered by tubercles, larger than those adjoining; a slight axillary web.

Color: Above brown to lavender brown with numerous more or less rounded black spots or flecks; dorsolaterally and laterally lighter brown with larger black spots or blotches which low on sides are separated by yellow; a large area of yellow in groin; chin white, with a few black flecks; venter and under surface of arms, hands, feet, and thighs white, without dark markings; front, back and dorsum of thighs bright yellow bearing three deep black bands; a very indistinct brownish wash on dorsum of thigh, tibia lavender brown above with dim black marks dorsally becoming a deep black on edges and on under side; tarsus, foot and toes banded with black; arms, above, banded very indistinctly; a white spot borders lip below eye; rest of upper lip brownish white interrupted by 4 brown spots; black spots about nostrils and on each side of anal flap.

Measurements in mm.: Snout to vent, 32; length of head, 9.2; length of eye, 3.9; length or orbit, 4.2; length of snout (mesial), 2; arm, 20; leg, 45; tibia, 15.2; foot and tarsus, 20.5.

Remarks: The relationship of this species cannot be stated. I suspected at first that it might be referred to one of the three forms described by Cope from Pico Blanco, especially to *Hyla pictipes.* These three forms, originally considered as subspecies of *Hyla punctariola* are very inadequately described. *Hyla punctariola* has been shown to belong to *Eleutherodactylus,* but it is presumed that the three forms are really members of the genus *Hyla.*

Cope describes *Hyla pictipes* as light brown above, not sharply bordered on the sides. Below white; edge of lip, tarsus, and outer toe, white. The sides are marbled with dark brown and yellow from near axilla to groin; and the front and back of the femora on each side of the superior brown longitudinal band are yellowish-brown spotted with bright yellow; two outer toes brown, inner toes yellow; humerus, cubitus and two outer fingers brown above. Back, lips, and belly unspotted. Two cotypes are known.

Three specimens were taken on weeds bordering a small roadside ditch; one was taken in forest on a plant growing in a small rivulet. Numerous specimens were heard calling from a tiny spring-fed rivulet, but none were found since the calls ceased when one approached.

The species is named for the great finca of Moravia. The genial owner, Sr. Don Fernando Alvarado Chacon, to whom I am greatly indebted, permitted me to collect there, and provided me with excellent quarters. For this I am deeply grateful.

Hyla loquax Gaige and Stuart

Figure 58

Hyla loquax Gaige and Stuart, Occ. Papers Mus. Zool. Univ. Michigan, No. 281, 1934, pp. 1-3 (Ixpuc Aguada, north of La Libertad, El Petén, Guatemala); Taylor and Smith, Proc. U. S. Nat. Mus., vol. 95, 1945, p. 587 (Piedras Negras, Guatemala); Taylor, Amer. Mus. Novitates, No. 1473, Dec. 7, 1949, p. 12 (Río Chicapa, Oaxaca).

?*Hyla stadelmani* Schmidt, Proc. Biol. Soc. Washington, vol. 49, 1936, p. 45 (Subirana Valley, 2800 ft. altitude, Yoro, Honduras).

Diagnosis: Medium-sized frogs, the adult males measuring from 37-45 mm. snout to vent; an extensive axillary web; a fold across the breast; fingers about one fifth, toes fully, webbed; a distinct inner glandular tarsal fold present; heels of adpressed limb reaches to eye; heels do not overlap when legs are folded at right angles to body; vocal sac large, limited by breast fold; choanae distinctly smaller than the raised vomerine tooth fasciculi, which are separated from choanae by a distance nearly twice that between the fasciculi; legs, on concealed surfaces, and groin, reddish or reddish orange.

Description of species: (K.U.M.N.H. No. 24614; Turrialba, C. R.) Medium-sized hylas (snout-to-vent length of males and females about equal); head usually not as wide as body; width of head (15 mm.) nearly same as head length (14.8 mm.); orbits but little elevated; regions about nostrils very slightly swollen, with a slight depression between them; tympanum distinct (2.1 mm. long and 2.3 mm. high) bordered by a slightly elevated rim; separated from the eye by a distance equal to its length; eye length, 4

mm. the posterior section of lid slightly separated, its edge nearly vertical; width of eyelid in interorbital interval one and two-thirds times; no canthus; distance between eye and nostril, 3.7.; from nostril to the median indefinite notch in upper lip, 3.4 mm.; loreal region not concave, sloping obliquely to lip; length of snout, 4.3 mm.; the tip extending beyond lip 1.2 mm.

Tongue subcircular, only posterior edge free; vocal sacs very large, the vocal slits elongate, opening just inside of jaw edge; choanae small, lateral, separated by a distance of 4.5 mm.; vomerine teeth in two fasciculi, each about size of a choana situated between choanae but extending anterior to their anterior level and not reaching their posterior level, closer to each other than to choanae;

FIG. 58. *Hyla loquax* Gaige and Stuart. K.U.M.N.H. No. 29609; Turrialba, Costa Rica; snout-to-vent length, approx. 42 mm.

openings of palatal glands in a continuous, nearly straight groove a little closer to tooth fasciculi than to front of palate.

Skin finely corrugated with indications of a very few lateral pustules; sides slightly wrinkled, venter and much of the ventral face of thigh covered with strong granules; a short anal flap; vent high followed by a groove flanked with numerous granules; skin leathery, on back largely underlain by a layer of pure white glandular tissue; a very ample vocal sac visible externally; a fold from eye overhanging tympanum is continued on side for some distance.

Arm short, the wrist barely extending beyond snout tip; fingers with broad terminal discs, those of outer fingers equal or slightly larger than tympanum; inner finger less than one-third webbed; nearly two-thirds webbed between second and third and third and fourth, the webs reaching most of the discs as narrow fringes; subarticular tubercles all single; numerous granules on palm; palmar tubercle rather indistinct, small; metacarpal tubercle large, widening base of first finger; latter surmounted by a nuptial swelling covered with small asperities but not horn covered (at this time of the year at least); an indistinct row of tubercles under forearm; a well-developed axillary web attaching to outer third of humerus.

Leg short, the heel reaching near front edge of eye; toes four fifths to fully webbed, the webs reaching discs of toes except fourth; a small inner metatarsal tubercle; an inner tarsal fold present; a fringe on outer toe continued more or less on tarsus as an outer tarsal fold or ridge; web and under side of toes with irregular granules; discs on toes smaller than those on fingers.

Color: Generally brownish or dark brown above with some fine indefinite scattering of darker pigment; wide area in groin, posterior face of thigh, tibia and part of foot reddish to reddish orange; venter, lower part of sides (anteriorly) under arms, chin and throat canary to lemon yellow; under side of tarsus and much of foot with dark brown pigment.

Measurements in mm.: Snout to vent, 42; width of head, 15; length of head, 14.8; length of snout, 4.3; length of eye, 4; arm, 27; hand, 13; leg, 63; tibia, 21; foot and tarsus, 29.

Variation: Dorsally, color generally red or orange brown; some slight scattered darker pigment, with numerous small black dots or with a rather large hourglass pattern on the head and shoulders. A few specimens are somewhat olive in color. In life the olive color is rather prevalent at night but in daylight this assumes a reddish orange-brown color and the dark pattern becomes more or less

evident; color of sides, venter, throat, chin and underside of limbs and thigh, canary to lemon-yellow. The groin, sides of thigh, tibia and part of foot reddish or reddish orange or orange. This color does not disappear in preservative for many months, in which case the entire concealed surfaces become whitish in color. In a few specimens there is only a broad pigmented stripe across the dorsal surface of thigh but in others there may be only scattered pigment present.

Remarks: A series of thirty-two specimens taken at various times during the summer from an artificial pond at the Inter-American Institute of Agriculture at Turrialba, Costa Rica, have been referred to this species, that was originally described from El Petén, Guatemala. Specimens have been taken as far north as southern Oaxaca. I have examined the types of *Hyla stadelmani* from Honduras and I believe this represents the same species. I have not directly compared them with the type of *loquax* but any differences that might be noted when compared with a paratype could be regarded only as of subspecific value, if that. The original description of *loquax* fails to mention the extensive axillary webs which attach far out on the outer third of the upper arm.

Only one pair was found clasping (June 24). They were heard at night throughout the summer at such times as I was in the neighborhood of the pond until I left, September 15. I suspect that they called every night. The specimens were perched on reeds and papyrus growing in or on the edge of the water and were usually perched one to four feet above the water level. Their loud harsh "quacks" make one suspect that they are well named.

In 1951 I found the species at Moravia (south of Turrialba). Here the species was calling from the lotus leaves floating on a small pond. The calling continued all night long, occasional calls being heard in the daytime.

Hyla pseudopuma Günther

Figures 59, 60

Hyla puma Boulenger, Proc. Zool. Soc. London, 1898, p. 478 (*non* Cope).
Hyla pseudopuma Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, pp. 274-275, pl. 72, figs. A and B (type locality, La Palma, Costa Rica, 1600 m. alt. Specimens from the Museo Nacional de Costa Rica); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, p. 254.

Diagnosis: A medium sized species, female reaching a length of 46 mm.; nostril nearly equidistant from eye and from median notch in upper lip, or slightly closer to eye, the snout in lateral profile sloping obliquely to lip; canthus distinct, rounded; greatest diameter

of tympanum equal to three fourths the length of the eye; latter relatively small; supratympanic fold curves down strongly behind angle of jaw; distal subarticular tubercles of all fingers double or bifid; toes between two thirds and three fourths webbed; chin and belly whitish, or with some darker pigment; some white spots or flecks along the lower edge of the darker coloration of sides; an hourglass-shaped figure may be present on back.

Description of species: (from MCZ No. 15308, Barba, Costa Rica.) Head as broad as body, its width (16 mm.) greater than its

FIG. 59. *Hyla pseudopuma* Günther. Copied from Günther, Biologia Centrali-Americana, Reptilia and Batrachia, pl. 72, fig. A; La Palma, Costa Rica; snout-to-vent length, approximately 40 mm.

length (14 mm.); canthus distinct, slightly rounded; upper part of lores nearly vertical, lower part sloping obliquely to lip; top of snout nearly plane, the swelling about nostrils not strongly developed; tympanum diagonally oval, its upper part concealed by supratympanic fold, its greatest diameter (3 mm.) greater than the length (2.8 mm.), its distance from eye (2 mm.) much less than its diameter; eye relatively small, the length of the opening (3.9 mm.) equal to its distance from nostril, but less than the length of snout (6

mm.); upper eyelid (3 mm.) much less than interorbital width (4.4 mm.); snout tip, in profile, sloping downward toward lip, the lower part rounded; a strong fold from eye curves across top of tympanum and down close behind angle of jaw.

Choanae relatively small, diameter of one in distance between them nearly six times; vomerine teeth in two fasciculi between posterior part of choanae, but tooth rows usually behind posterior level of choanae, separated mesially from each other by a distance one fourth length of a fasciculus from choanae by a little more than half the length of one; tongue broadly cordiform or rounded in front, narrowly notched behind, a little wider than long, not or scarcely free behind; males with elongate vocal slits; openings of palatal glands in a sinuous line, nearer end of palate than anterior level of choanae.

Arms short, moderately thick (more especially so in males) the musculature tending to hold the arms fixed and flexed at right angles, making it difficult to straighten them without breaking muscles; a small but indistinct axillary web. A vestige of a web between inner fingers; second finger with the web two fifths of its length with a broad fringe that reaches disc while on fourth finger the fringe is very narrow; outer fingers two-fifths webbed, the fringes narrow; outer metacarpal tubercle large, compressed, the palmar tubercle rather indistinct, tripartite; a more or less distinct line of rounded tubercles on under surface of arm; distal subarticular tubercles of fingers all double or strongly bifid (occasionally single on second finger); heel reaches to nostril or tip of snout; knee and elbow barely overlap when adpressed on body; an inner metatarsal fold present; inner metatarsal tubercle small, outer very small but distinct; toes four fifths webbed, webs on toes reaching to disc on second, third and fifth, but somewhat excised between them; first toe about half webbed, others two fifths to three fourths webbed; discs of fingers a little less than size of tympanum; toe discs distinctly smaller; when legs are folded at right angles to body, heels overlap four millimeters.

Skin on dorsum generally smooth (sometimes with scattered fine tubercles dorsolaterally); on sides skin wrinkled, and broken into fine elongate folds; chin and breast rather indistinctly granular the granules scattered; venter strongly granular, under side of femur with granules, a few on the posterior part enlarged somewhat and elevated; anal flap moderately elongate, the vent high; a groove following vent flanked by granules.

Color in preservative: Markings generally gray brown, the snout

brownish; a large lighter-centered black-edged spot beginning between eyes, the posterior outline forming a curve; two convex curved lines on middle of back; almost entire surface of back with very numerous minute black flecks; arm and leg banded with dusky; side of body dark blackish, with several small cream spots more numerous in groin; ventral surface generally light with a few brownish flecks on a whitish chin; front and back surfaces of femur strongly pigmented; lateral dark coloration of side encroaching on sides of neck. Under surface of the tarsus strongly black flecked. (Frequently the markings are in the shape of an hourglass beginning between the eyes and extending to the rump. Occasionally specimens lack dorsal markings and are grayish white on the back, or dark gray to brown.)

Colors given in the type description are "plum-colored," the "concealed surfaces of the femur uniform dark, like back, but without spots. Lower parts white, throat speckled brown. The groin where the two colors meet shows some marbling or spotting. Another variety has a grayish or white back; a broad deep brown fascia on the side of the body starts from the eye and tympanum, and is variegated with more or less numerous yellow spots along its lower margin."

Measurements in mm.: Snout to vent, 43; length of head, 14; width of head, 16; length of eye, 3.9; diameter of tympanum, 3; length of snout, 6; arm, 29; hand, 13.5; leg, 71; tibia, 23.5; foot and tarsus, 13.

Remarks: Males have the dorsal surface of the base of the first finger with a nuptial swelling covered with numerous blackish spines. The penultimate joint is about one third covered.

One young male from Barba, C. R. in MCZ, under a lens shows the skin corrugated on the hand, and the canthus is slightly angular.

The species is known in Costa Rica from La Palma, La Estrella, Volcán Barba, Volcán Poás, and Moravia. It has also been reported from Panamá.

Four specimens from Volcán Barba are dark black-brown above with dark pigment spots on chin (Nos. 30179-30182). In a series (Nos. 30183-30190) taken at approximately 6800 feet on the western slope of Volcán Poás, males are gray olive above with a slightly darker lateral band on which some lighter marks are evident. The females are larger, darker lavender or brown above with the hourglass marking either present or absent.

Two specimens, a male (No. 30191) and a female (No. 30192) taken at Moravia are referred here with some reluctance. The

male has the nostril much nearer the eye than the lip (the female slightly so), the snout being pointed; the dark olive lateral stripe begins behind the eye and extends to groin and bears several discrete cream or cream yellow spots. The female does not show the lateral stripe distinctly but the cream yellow spots are present. There is a triangular dark mark on the head and a large quadrangular dim dark mark on middle of the back. There are a few

FIG. 60. *Hyla pseudopuma* Günther. K.U.M.N.H. No. 28199♂; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 43 mm. (This specimen differs somewhat from Günther's figure given with the type description, pl. 72, figs. A and B.)

small rounded black spots on back and head. The general habitus suggests *pseudopuma*. The male when first taken secreted a slimy fluid that when placed in a little water tended to make the water sirupy in consistency. I have not noticed this secretion on the typical specimens of Barba.

Specimens, except for the last two mentioned, were taken in bromelias during the day. They varied much in color from blackish to yellow but in captivity they all became nearly a uniform olive above, after a time. The lot from Barba again darkened when kept in a sack overnight.

Hyla zeteki Gaige

Figure 61

Hyla zeteki Gaige, Occ. Papers Mus. Zool. Univ. Michigan, No. 207, Sept. 28, 1929, pp. 4-6 (type locality, Caldera Valley above Boquete, Chiriquí Province, Panamá; H. T. Gaige, coll.); Dunn, Copeia, 1937, pp. 164-167.

Diagnosis: A diminutive hylid with a distinct tympanum facing more upward than outward, its diameter approximately one third the length of eye; snout very short, canthus absent or indistinct, rounded, curving forward, the loreal region strongly concave; nostrils nearly terminal; outer fingers less than one-third webbed; outer toes about two-fifths webbed; inner less than one-fourth webbed; a pair of elongate, strongly elevated tubercles below vent curving

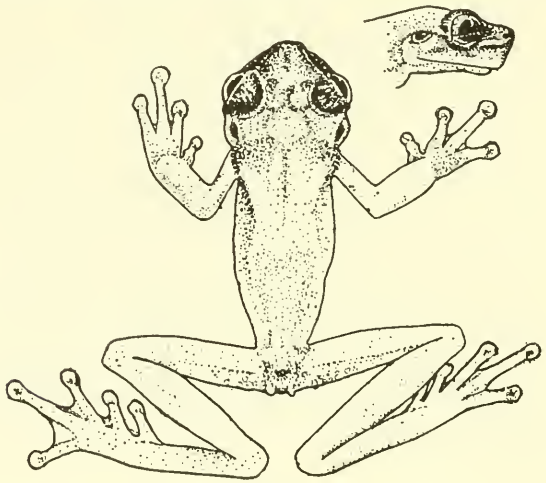

FIG. 61. *Hyla zeteki* Gaige. K.U.M.N.H. No. 28183 ♀; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 25 mm.

under thigh; finger discs much larger than tympanum; sides with flat granules; red marking usually present on back, and spectacle-like marks surrounding eyes; arm strongly covered on front and ventral side with tubercles or granules.

Description of the species: (From K.U.M.N.H. No. 28183, Isla Bonita, C. R. ♀.) Head broader than body, the eyes large, protuberant, directed somewhat forward; width of head (8 mm.), minutely greater than length of head (7.9 mm.); canthus rostralis very indistinct, rounded on edge, and strongly curved from eye to nostril; the nostrils nearly terminal, tip of snout blunt, its profile nearly vertical, extending but slightly beyond the mouth; areas about nos-

trils slightly swollen, with an indistinct depression behind and between them; loreal region concave; lores nearly vertical on upper part then sloping obliquely to lip; a fold from eye above tympanum curves somewhat inward, permitting back part of the jaw to be seen from above; tympanum distinct, directed obliquely upward, somewhat elevated, strongly pigmented, its upper edge covered by the fold, its diameter (.9 mm.) a little less than one third length of eye (3 mm.); the distance between tympanum and eye a little more than twice diameter of tympanum; length of eye (3 mm.) considerable greater than length of snout (2.65 mm.); width of an eyelid (2.1 mm.) less than interorbital distance (3 mm.); distance between nostrils 1.7 mm.

Choanae moderate, diameter of one (.4 mm.) contained in the distance between them, five times; vomerine teeth in two fasciculi somewhat diagonally arranged between posterior part of choanae but extending some distance behind their posterior level, each fasciculus as large as or larger than a choana, separated from each other by a distance of little less than their distance from choanae. Palatal glands opening through a series of separate pores, the series curving back to near the anterior level of choanae; tongue very large, flat, its width (5 mm.) greater than its length (4.7 mm.) free for less than one fourth of its length, the maxillary shelf continuous, concealing front part of palate when seen from below; openings of the Eustachian tubes nearly as large as choanae.

Arm short, slender, the wrist barely reaching tip of snout; inner fingers with only a trace of web; the two outer about one-third webbed; discs large (1.3 mm.), much wider than the digits; distal subarticular tubercles on all fingers double or bifid; a large inner metacarpal tubercle; outer palmar tubercle tripartite moderately distinct; surface of palm and fingers covered with strong granules; a row of flat indistinct tubercles under arm. Leg short, the heel reaching to front level of eye; between two inner toes only a vestige of a web; between second and third, one-third webbed; between outer toes about two-fifths webbed; narrow fringes reaching the discs on all toes; a strong but short inner metatarsal tubercle; a small indistinct outer tubercle, scarcely distinguishable from small granules covering foot; no distinct tarsal fold but the surface indistinctly granular and toward heel some elevated tubercles.

Skin of head smooth; under lens dorsal surface of body and to a lesser extent the legs, finely corrugated; sides, beginning at tympanum, finely granular as are chin and breast; *under surface of arm*, as well as breast and venter, strongly granular; under surface

of thigh almost entirely covered with larger granules, irregular in size, and with two large elongate elevated tubercles below vent, separated by granules; vent near upper level of thigh with a short flap; skin in groin and on front and back of thigh relatively smooth.

Color in life: Head brownish olive; dorsal surface dull lemon; below, on belly, sides, and on limbs, flesh white; eyes dark; a yellow line from nostril to eye bordered above and below by darker.

In preservative the color is slightly lavender-tan, the pigment very sparse; some distinct darker spots on top of snout; a dark line along upper loreal region and a lighter area on the eyelid is outlined by darker pigment, the light area itself is crossed by some indistinct darker stripes; another from below nostril to eye, the two separated by a light line; eyelids dark.

Measurements in mm.: Snout to vent, 25; head width, 8; head length, 7.9; eye length, 3; diameter of tympanum, .9; interorbital distance, 3; length of snout, 2.65; arm, 14; hand, 7.2; leg, 38; tibia, 14; foot and tarsus, 18.2.

Remarks: This small species was obtained from bromelias at night. Its relationship is obscure since the characters of the male are as yet unknown.

The specimen differs but little in color and marking from the type description. No median red streak was present or red in the other coloration. The black "spectacle-like" markings around eyes meeting mesially are not clearly defined; the eye is distinctly longer than snout, the toe discs smaller than finger discs.

Hyla picadoi may be distinguished from it by the concealed tympanum, the strong glandular area in the temporal region, the distinct "nose", and the two toothlike projections in the lower jaw.

The Costa Rican specimens of *Hyla zeteki* referred to by Dunn (*loc. cit.*) differ from the type in the absence of the red dorsal marks as well as the pecular head markings. The type series also has certain specimens in which the markings are largely absent.

My specimen was taken from a bromelia along with *Eleutherodactylus diastema* and was not recognized in the field. The locality is Isla Bonita, eastern slope of Volcán Poás, at an elevation of approximately 5500 ft.

Hyla pictipes Cope

Hyla punctariola pictipes Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875 p. 106 (type locality, Cordilleras, 5000-7000 ft. on Pico Blanco, Costa Rica; Wm. Gabb coll.)

Hyla punctariola Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the Collection of the British Museum, 2nd ed. 1882, p. 401 (*part.*); Nieden, Das Tierreich, Lief. 46, Anura I, 1923, pp. 256-257, (*part.*).

Diagnosis: This hyla may be distinguished by the following characters: Small hyla (male 26 mm. female 29 mm.) snout to vent; first finger with scarcely a trace of web; between second and third fingers, one third webbed; between outer fingers one fourth webbed. Width of choana in distance between choanae, three times; tongue free for about one fifth of its length. Sides with broad light area enclosing darker spots; groin dark enclosing white or cream spots; white spots on front and back of thigh.

Description of type: The type specimens are old and much softened and many of the characters of this poorly described species cannot be determined by examination.

Head moderately wide (9.9 mm.) slightly greater than length (9.5 mm.); tympanum small, .8 mm. in diameter a little less than one third of the eye length (2.6 mm.); distance between eye and nostril (2.1 mm.) less than eye length; loreal region concave; nostrils nearly terminal; upper part of tympanum partly concealed by the supratympanic fold.

Choanae rather large the width of one (.8 mm.) in the distance between them (2.5 mm.) three times; vomerine teeth in two small groups between but extending behind posterior level of choanae. Tongue as wide as long (5.5 x 5.5 mm.) free for more than one fifth of its length; vocal slits large; openings of the Eustachian tubes equally as large as choanae.

Arm moderate; scarcely a trace of web between first two fingers; between the second and third, approximately one third webbed; between the two outer fingers, a little more than one fourth webbed; outer finger with a bifid subarticular tubercle; leg moderately long, the heel reaches to the nostril; the two inner and two outer toes approximately half webbed; between inner toes, two thirds webbed; an axillary web present.

Color: Light brown above, not sharply bordered on the sides; ventral surfaces white; edge of upper lip, tarsus, and outer toe white; sides marbled with dark brown and yellow from near axilla to groin; the front of thigh dark brown with four or five bright yellow spots; back of thigh dark with irregular yellow spots, the spots small and scattered; under side of tibia with white or yellow spots; a light line along outer edge of foot; anal opening high on thigh, the area about vent with some white color.

Measurements in mm. of cotypes Nos. 30652 ♂ and 30631 ♀ : Snout to vent, 26, 29; width of head, 9.9, —; length of head, 9.5, —; length of eye, 2.6, —; tympanum (diameter) .8, —; arm, 17, —; hand, 8, —; leg, 43, 52; tibia, 15, 16; foot and tarsus, 18, 22.5.

Remarks: In No. 30631, the brown of the back and the light color of the sides tend to dovetail. There is a pair of subanal tubercles colored white. The groin is dark with discrete yellow spots.

Compared with *moraviaensis* the head is proportionately longer, 9.9 wide by 9.5 long (in *moraviaensis*, 11.8 by 9.2); lip white in *pictipes*, with four strongly defined black brown spots, separated by lighter areas in *moraviaensis;* heel reaches to nostril in *pictipes*, to middle of eye in *moraviaensis*. The eyes are more prominent and the dorsal coloration is different.

Hyla debilis sp. nov.

Figure 62

Type: K.U.M.N.H. No. 28184. Isla Bonita, (American Cinchona Plantation) eastern slope Volcán Poás, 5600 ft., August 1, 1947; Richard C. Taylor and Edward H. Taylor, collectors.

Paratype: R.C.T. No. 786; same locality and data.

Diagnosis: A diminutive species 26.2 mm. snout to vent; a moderately sharp curving canthus, the snout subtruncate, the sides vertical, in profile snout pushing out strongly beyond lip; tympanum half the length of eye opening, separated from eye by less than its diameter; outer finger only with distal subarticular tubercle double; uniform olive above with a single narrow elongate white glandular spot on side beginning near middle and reaching near or to the groin; a long light spot on lip at base of snout, another below eye; venter light flesh without dark flecks.

Description of type: Head length (8 mm.) greater than its width (7.5 mm.); eyes strongly flaring out; snout short subtruncate; canthi slightly rounded, curving to above nostrils; loreal region nearly vertical, not or but slightly concave; tip of snout extends nearly 2 mm. beyond lip, the nostrils nearly terminal; top of head flat, not depressed, the area about nostrils not or scarcely swollen; tympanum distinct, longer than high, not covered by skin, its surface shiny, its upper edge concealed by a supratympanic fold which runs diagonally from eye to above arm and continues as a free fold to groin; diameter (length) of the tympanum (1.85 mm.) a little greater than its distance from eye (1.6 mm.); length of eye opening (3.1 mm.) greater than snout length (2.3 mm.); nostril closer to eye than to the median point of upper lip; width of an eyelid (2.3 mm.) less than interorbital distance (3 mm.).

Choanae moderate, somewhat lateral, the inner edges straight, the diameter of one in distance between them 2.8 times; vomerine teeth in two almost contiguous fasciculi between the posterior part

of choanae but extending much beyond their posterior level; separated from choanae by less than half width of one fasciculus; tongue as long as wide, slightly emarginate behind; one sixth free behind; vocal slits elongate, considerably mesial from edge of mandible; an external vocal sac indicated.

Wrist extends considerably beyond tip of snout; axillary web small but distinct; first finger very small, with a vague web remnant; second more than one fourth webbed with a broad fringe on the outer edge to disc; outer fingers half webbed; fourth finger with a

FIG. 62. *Hyla debilis* sp. nov. K.U.M.N.H. No. 28184, Type; Isla Bonita, Volcán Poás, Costa Rica; actual snout-to-vent length, 26.2 mm.

distal subarticular tubercle double; diameter of largest finger disc 1.3 mm.; that of first finger .6 mm.; inner metacarpal tubercle large, partly covered by a swollen nuptial gland, which covers part of base of first finger but does not reach penultimate joint; palmar tubercle quadripartite, scarcely distinguishable from granules of hand.

Heel reaches to behind middle of eye; no inner or outer metatarsal fold; inner tubercle small, outer still smaller, flat; inner toes one third webbed; outer toes a little more than half webbed; discs of toes not or but slightly smaller than finger discs; heel and elbow overlap on side; when legs are folded the heels overlap .5 mm.

Skin glassy smooth, under lens minute pores visible. Chin, throat,

and breast smooth without a breast fold; venter, part of sides, part of under side of femur strongly granular; vent high, followed by a small groove flanked on each side by a flat tubercle; each of these in turn touching a much larger flat tubercle lying lateral to and partly behind it.

Color: Dorsally, uniform dark olive on back, top and sides of head; tympanum lighter, somewhat brownish; a bandlike light spot extends around snout on edge of upper lip, highest in front; this separated completely from an elongate white spot below eye and entering orbit; a white spot on sides in lumbar region extending nearly to groin bordered below by olive; arms and limbs yellow-olive; above yellowish flesh on concealed parts; front of femur pigmentless as is the greater part of the posterior surface; under surface of foot pigmented; hand without pigment; no ventral flecks.

Measurements of type and paratype respectively (in mm.): Snout to vent, 26.2, 26; width of head, 7.5, 7.3; length of head, 8.8; length of tympanum, 1.85, 1.65; length of eye, 3.1, 2.9; length of snout, 2.3, 2.3; arm, 27, 26.8; hand, 7, 6.8; leg, 37.2, 38; tibia, 12, 12.4; foot and tarsus, 17.4, 16.7.

Variation: The paratype has minute brown spinules on the nuptial swellings suggesting sexual maturity (visible under a lens), and the skin is shown to have minute corrugations in both specimens. The lateral spot shows the presence of minute skin glandules suggesting that the spot is actually an indistinct lumbar gland. In the paratype there is an indistinct unpigmented line above outer side of the tarsus and a suggestion of an outer tarsal fold.

Remarks: This form, occurring as it does in the same general area with *Hyla rivularis*, might be mistaken for it, since the snout overhangs the lip, the loreal region is nearly vertical, and the vomerine teeth have the same relative position. The presence of the lumbar glandular spot, absence of ventral spotting, the white markings on the head, and the large distinct tympanum amply separate the forms. It is seemingly a smaller species. There is likewise a marked difference in the call.

Specimens were found at night by tracing their feeble calls to plants growing in a small stream. In the same general region specimens of the rare *Phyllomedusa lemur* were taken by Richard Taylor.

Hyla alvaradoi sp. nov.

Figure 63

Type: Kansas University Mus. Nat. History, No. 30886; collected at Moravia, Costa Rica (on the Caribbean Slope), Aug. 16, 1951, by Edward H. Taylor.

Diagnosis: A small hyla, snout to vent, 32 mm.; terminal digital discs of fingers equal, but not wider than digits; those on toes somewhat narrower than digits; tympanum more or less distinct, covered with skin, and separated from eye by a distance greater than its diameter; top of head flat, without obvious swelling about nostrils; outer fingers less than one third webbed, toes a little more than four fifths webbed; inner tarsal fold rather indistinct on mesial ventral part of tarsus; tibiotarsal articulation reaches anterior edge of eye; fasciculi of vomerine teeth between posterior part of choanae, their outer ends extending somewhat behind choanae, the teeth

FIG. 63. *Hyla alvaradoi* sp. nov. Type. K.U.M.N.H. No. 30886; Moravia, Costa Rica; actual snout-to-vent length, 32 mm.

rows arranged in a broad V shape. Cream yellow in life with a white line from behind eye to a point above arm; skin minutely corrugated with a very sparse scattering of pigment.

Description of type: Head flat, the snout not extending beyond lip; canthus distinct, slightly rounded, forming nearly a straight line between eye and nostril; area about nostril only slightly swollen, the loreal region somewhat concave, the upper part nearly vertical, the lower sloping rather abruptly to lip; a fold from eye to a point somewhat beyond back level of arm insertion, covering upper edge of tympanum; latter covered with skin, but evident, its greatest diameter (1.5 mm.) less than half length of eye (3.85 mm.); dis-

tance from eye to nostril (3 mm.) about equal to median snout length (3.1 mm.); width of head (12 mm.) equal to head length; eyes not prominent, not or but slightly elevated, the width of an eyelid (2 mm.) in interorbital interval, 2.5 times; choanae relatively large, the diameter of one in distance between, about 3.2 times; vomerine teeth in two rather high fasciculi, situated between posterior half of choanae but extending behind them, the teeth forming a broad, inverted V-shaped series separated mesially by a distance equal to a third of length of a fasciculus, and from choanae by a distance a little more than half length of a fasciculus; tongue relatively small, subcircular, slightly longer than wide; vocal slits at some distance from jaw bones, largely lying behind tongue; openings of Eustachian tubes distinctly smaller than choanae; vocal sac can scarcely be discerned externally; the gland on the tip of chin large, rather prominent.

Arm with wrist reaching considerably beyond tip of snout; fingers short, the second a little longer than first, the terminal pads not wider than digits; merest remnant of web between first and second fingers; between second and third, the web about one fourth length of second finger; between third and fourth, about one third webbed; a thickened ridge under arm but without tubercles or a fold; large metacarpal tubercle showing no trace of nuptial swelling or nuptial asperities; subarticular tubercles small, single, other tubercles indistinct or obsolete; toes tapering slightly, the terminal discs not as wide as digits; toes three fourths webbed (or a little more); inner metatarsal tubercle indistinct, not or but slightly elevated; outer tubercle presumably absent; inner tarsal fold may be represented by an indistinct thickened mesial ridge on underside of tarsus; tibiotarsal articulation to anterior part of eye; legs folded at right angles to body, the heels touch or barely overlap; no dorsal folds except a supratympanic fold that crosses the shoulder; a pair of folds arising in front of arms and continuing back diagonally on thighs for some distance; a distinct groove below vent; skin practically smooth (under a lens very finely corrugated); venter and under side of thigh with somewhat flattened granules. A very slight axillary web present.

Color in life: Dorsum greenish yellow, the yellow color predominating; hands and feet yellowish; legs yellowish with a slight greenish wash on toe pads but not under fingers; a cream-yellow line from eye back on shoulder; venter cream; under legs flesh with a slight yellow tinge; vocal sacs seemingly paired; a whitish glandular area on tip of chin; sides yellow cream, nearly uniform with a slight

brownish wash dorsolaterally; an orchid yellow line borders the anal flap.

In preservative the yellow has disappeared leaving the creature white but with a sparse peppering of fine black pigment with occasional larger spread chromataphores, and a scattering of minute rounded cream dots on the dorsal surfaces; iris mixed shades of brown; pupil a narrow horizontal slit. The muscles appear whitish below skin.

Measurements in mm.: Snout to vent, 32; width of head, 12; length of head, 12; diameter of tymmpanum, 1.5; length of eye, 3.85; arm, 21; leg, 55; tibia, 18.5; foot and tarsus, 25.5.

Remarks: I am unable to discover the relationship of this species. The character of the pigment suggests a similarity to *Cochranella* and *Centrolene*, but the astragalus and calcaneum are not fused. It may be a relative of *Hyla vilsoniana* Cope.

The specimen was captured at night on a green plant growing on the edge of a small forest rivulet. In the same immediate locality specimens of *Hyla rufioculis, Hyla moraviaensis* and *Cochranella talamancae* were also taken.

Hyla ebraccata Cope

Figure 63a

Hyla ebraccata Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, p. 69 (type locality, Nicaragua, John F. Bransford coll.); Brocchi, Mission Scientifique au Mexique . . .; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1881, p. 44; Taylor and Smith, Proc. U. S. Nat. Mus. vol. 95, 1945, p. 587, fig. 60 H.

Hyla leucophyllata Taylor, Univ. Kansas Sci. Bull., vol. 28, 1942, p. 30.

After an examination of certain specimens in eastern Museums labeled *Hyla leucophyllata* Beiris, from Central and South American localities, I am forced to conclude that more than a single species is involved. This, despite the fact that certain forms already described have been thrown back into synonymy. At the moment it is impossible for me to determine which form should bear the name *leucophyllata*. I feel reasonably certain that it does not apply to the form occurring in Central America. Hence I am following Taylor and Smith (*loc. cit.*) in the use of Cope's name, *ebraccata*.

Diagnosis: This species may be diagnosed as follows: diminutive frogs (males 27 mm., females 32 mm. in snout-to-vent length); snout short, rather blunt, the loreal region nearly vertical; outer fingers between one half and two thirds webbed; toes four fifths webbed. A strong tarsal fold and strong axillary web; a band of darker pigment from snout to groin, often merging with the darker dorsal

marks; a dark triangular figure beginning between eyes often continuous with a large irregular spot on middle of back, sometimes together forming an hourglass figure.

Description of species: (K.U.M.N.H. No. 24694 ♀, Turrialba, C. R.) Head width (10.1 mm.) a little greater than length of head (9.2 mm.); canthus distinct, rounded, strongly curving to nostril, the lores nearly vertical in the upper part, lower part slop-

FIG. 63a. *Hyla ebraccata Cope.* K.U.M.N.H. No. 24728; Turrialba, Costa Rica; actual snout-to-vent length, 28 mm.

ing obliquely to lip, not concave; nostrils nearly terminal, with but slight swelling about them, and none or a very insignificant depression between them; surface of snout depressed, the interorbital area slightly elevated; tympanum distinct, circular, directed outward and slighlty upward, heavily pigmented, its diameter 1.3 mm., separated from eye by 1.9 mm.; length of eye (3.2 mm.) about equal to length of snout (3.25 mm.); distance between nostrils equals their distance from eyes; nostril equidistant from eye and median notch in upper lip; width of an eyelid (2.2 mm.) distinctly less than the interorbital width (3.4 mm.); the supratympanic fold runs straight back above the tympanum, then curves abruptly down toward the arm inser-

tion; posterior line of border of eye slightly lobulate; choanae large rather lateral, the width of one (.8 mm.) contained in distance between them (3 mm.) a little less than four times; vomerine teeth in two small fasciculi equally distant from each other as from choanae, and lying between anterior part of choanae; tongue subcircular, as long as wide, notched behind (males with elongate, rather anterior vocal slits and a very ample vocal sac visible externally).

Arm moderately long, the wrist reaching beyond the tip of snout; inner fingers about one fourth webbed, the outer fingers nearly two-thirds webbed; subarticular tubercles of outer finger bifid; inner metacarpal tubercle elongate, 2½ times in length of first finger; palmar tubercle tripartite, not especially distinct; no distinct fold or row of tubercles under arm; heel reaches to the anterior edge of eye or between eye and nostril; toes four-fifths (or slightly more) webbed; a distinct inner tarsal ridge; inner metatarsal tubercle rather small, about four times in length of first toe; outer tubercle small; finger discs as large as tympanum.

Skin above moderately smooth (under a lens a fine corrugation is visible) and on the sides the skin is finely wrinkled; chin and breast lacking granulation; venter strongly granulate as is under surface of thighs; anal flap short, the vent high followed by a vertical groove flanked by a swollen tubercular ridge which terminates in a group of partly fused tubercles; practically no axillary web present.

Color: Above, the ground color is creamy white surmounted by a dark hourglass figure, sharply truncate anteriorly but extending on each side nearly to outer edge of eyelid; posteriorly the figure is irregular, there being several small dark spots scattered on rump; a few small yellow points on the dark figure; a dark stripe covers the end and side of snout and continues back along the side to groin; a cream white spot below eye; dorsal exposed surfaces of limbs banded with darker; entire thigh without pigment; humerus, save for a narrow stripe, without pigment; venter yellowish as are the concealed parts of the limbs.

*Measurements in mm. of K.U.M.N.H. Nos. 24719 ♂ and 24694 ♀ * respectively:*—Snout to vent, 27, 32; width of head, 8.6, 10.1; length of head, 7.6, 9.2; length of eye, 3, 3.2; length of snout, 2.3, 3.25; arm, 16, 20.2; hand, 7, 11; leg, 40, 52.5; tibia, 14.3, 18.3; foot and tarsus, 18, 26.

* Both specimens are from Turrialba.

Remarks: There is considerable variation in the shape and color of the dorsal dark spot. In a few cases the surrounding was darker than the spotting; in a few specimens the contrast between the spot and the ground color was slight and in one or two cases the specimens were uniform brownish.

Specimens were found on the farm of the Inter-American Institute of Agriculture at various times. The first discovery was on June 28. A large breeding population appeared near the central buildings after rains on July 2. Although relatively few females were taken, a series of more than a hundred was collected. Eggs were placed (almost invariably) on the underside of leaves or sticks out of the water, some at an elevation of as much as six feet; a second breeding group was found about three hundred yards from the first congregation in a pool in a coffee planting.

In 1951 I obtained a few specimens from the pond on the Farm, but no breeding population was heard during the summer.

Hyla phlebodes Stejneger

Figure 64

Hyla phlebodes Stejneger, Proc. U. S. Nat. Mus., vol. 30, pp. 817-818 (type locality, San Carlos, Costa Rica; Burgdorf and Schild coll.).
Hyla underwoodi Stuart, Univ. of Michigan, Mus. Zool. Mich. Publ., no. 29, 1935, p. 39 (*part.*).

Diagnosis: Small light-colored frogs with distinct irregular markings of dark brown on the back, but lacking a light-edged lateral brown stripe from snout to groin; tympanum distinct but covered with pigmented skin; eye length equals snout length; heel to eye or to between eye and nostril; a thick rounded inner tarsal ridge; vomerine teeth between choanae; proximal phalanx of fourth toe considerably wider than in other digits.

Description of species: Diminutive frogs, snout-to-vent 24 mm. ♂ ; width of head (8 mm.) greater than length (7 mm.); canthus rostralis distinct but rounded; top of head as far forward as nostril, flat, without depression; area about nostrils not or scarcely swollen; loreal region not or scarcely concave, sloping obliquely to mouth; nostrils not terminal, the snout, in profile, rounded, projecting one millimeter beyond mouth; tympanum distinct, pigmented, its upper edge covered by a fold from eye, which curves down behind the tympanum and continues back an indefinite distance on side; diameter of tympanum (1.25 mm.) contained in length of eye (3 mm.) approximately 2.5 times, tympanum separated from eye by 2.3 mm.; length of eye a little longer than length of snout (2.6 mm.); width of an eyelid (2.5 mm.) equal or slightly greater than interorbital

distance; vomerine teeth in two fasciculi between middle of choanae, separated from each other by a shorter distance than from the choanae; palatal glands opening into a groove, distinctly closer to choanae than to front of palate; tongue distinctly broader than long, not or very slightly emarginate and not free behind; large vocal slits near jaw, partly covered anteriorly by tongue; external vocal sac indicated by ample folds; seemingly the sac partially divided transversely into an anterior and posterior part.

FIG. 64. *Hyla phlebodes* Stejneger. K.U.M.N.H. No. 25729; Turrialba, Costa Rica; actual snout-to-vent length, approx. 24 mm.

Arm moderately long, the wrist reaching tip of snout; digits with broad discs, larger than tympanum; a vestige of a web between first two fingers; other fingers approximately one fourth webbed; fold under arm obsolete; subarticular tubercles large, single, except one on outer finger which may be bifid; supernumerary tubercles indicated, but not very distinct; a large inner metacarpal tubercle at base of first finger, above which is a small

nuptial swelling, but seemingly lacking nuptial asperities of any sort; palmer tubercle rather indistinct, tripartite.

Leg short, the heel reaching to middle of eye; heels overlap when legs are folded at right angles to body; toes with discs smaller than those on outer finger; toes wide, the proximal joint very much widened on the fourth toe; toes three-fourths webbed, the webs not reaching discs; subarticular tubercle present, large, flattened; no outer tubercle visible; no fringe on outer side of outer toe; no inner or outer tarsal folds.

Skin generally smooth on dorsal and lateral surfaces of head and body except for some very fine irregularities and occasional minute pustular tubercles; chin and breast smooth, venter covered with small granules; under face of thigh with much larger flat granules while area about vent is smooth; vent with a short, broad, anal flap; glandular areas just behind vent swollen, with a median groove between; a well-developed axillary web; vocal sac with vermiculate folds externally.

Color in life: Generally whitish cream above with a few irregular brown reticulations on head and body; femur yellow, mostly without dark pigment; throat and vocal sac bright yellow; venter yellowish cream; no lateral dark stripe, light edged above; iris of eye blackish; some pigmentation in anal region; no pigment on web of hand; some pigment on under side of outer toes.

Measurements in mm.: Snout to vent, 24; width of head, 8; length of head, 7; length of eye, 3; tympanum diameter, 1.25; snout length, 2.6; arm, 15; hand, 7; leg, 35.5; tibia, 12; foot and tarsus, 16.

Remarks: The type locality of *Hyla phlebodes* is San Carlos, Costa Rica, presumably the Commandancia de San Carlos at the junction of the Río Arenal and Río San Carlos in northern Costa Rica.

In certain of my previous publications I have followed Dr. L. C. Stuart in considering *Hyla phlebodes* Stejneger a synonym of *Hyla underwoodi.* Having acquired a series of specimens of the former from Costa Rica, it becomes most evident to me that two distinct species are involved. *Hyla underwoodi* Boulenger belongs in a different species group of the genus *Hyla,* characterized by a broad brown stripe along the sides of head and body bordered above by a white, yellow or silver colored line. In this group are the Central American species *Hyla microcephala* Cope from Chiriquí, Panamá, which may or may not be distinct from *underwoodi,* and *Hyla robertmertensi* Taylor from Chiapas, Mexico.

Altogether, eleven specimens of *H. phlebodes* were taken at Turrialba (altitude about 1995 ft.). These were all solitary males whose presence was made known by their feeble calls. Four were obtained from weeds growing in a shallow pond near the Inter-American Institute of Agricultural Sciences. In the pond, numerous individuals of *Hyla loquax* Gaige and Stuart also were calling. Seven other *phlebodes* were taken in high grass and weeds in the environs of the pond. Here, at the same time, *Hyla eleachroa* and *Hyla ebraccata* were found breeding in shallow rain-pools.

Cope's *Hyla microcephala* from mountain streams in the Department of Chiriquí, Panamá, is described as having fingers free, toes almost fully webbed to discs; tympanum one third of the eye; eyes prominent; heel beyond end of snout; discs not as large as tympanum; a narrow brown band on each side of the back and a lateral [dark] band white-edged above; body slender with a small head. These are characteristics which do not agree with those of *Hyla phlebodes*.

I have examined two small frogs of this group from Barro Colorado Island, Canal Zone (A.M.N.H. Nos. 40470-71). Superficially they resemble *Hyla phlebodes* but the following differences are in evidence: Eye golden (in preservation); sides of snout and body with a broad stripe darker than dorsum bordered above by a light line; eyes more prominent; discs on fingers and toes smaller, not equal in size to tympanum; dorsal and posterior part of thigh covered regularly with finer black dots; toes webbed almost to discs, the webs somewhat emarginate; the proximal phalanx of the fourth toe not equally widened; there is a trace of an inner tarsal fold; some indistinct darker markings on silvery gray dorsum. This is possibly the form that has been reported from Barro Colorado as *Hyla underwoodi*. I have examined no specimens of *underwoodi* from Costa Rica.

Hyla underwoodi Boulenger

Figure 65

Hyla microcephala Boulenger, Proc. Zool. Soc. London, 1898, p. 481, pl. 39, fig. 3 (type locality, Bebedero, Costa Rica, coll. Mr. Underwood; *non* Cope 1886).

Hyla underwoodi Boulenger, Ann. Mag. Nat. Hist., ser. 7, vol. 3, Apr. 1899, p. 277 (new name for *Hyla microcephala* preoccupied); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, p. 278; (?) Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, 1933, pp. 413, 420 (this is very probably *Hyla phlebodes*); *idem*, vol. 8, 1933, pp. 64, 72 (probably *H. phlebodes*); Stuart, Univ. Mich. Mus. Zool. Misc. Publ. No. 29, 1935, p. 39 (*part.*); Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, p. 85 (*part.*).

Despite the statement of Stuart (Univ. Mich. Mus. Zool. Misc. Publ. No. 29, 1935, p. 39) that Mr. Parker of the British Museum had compared a specimen of *Hyla phlebodes* Stejneger with the type of *Hyla underwoodi* Boulenger and that he "states that differences, such as the slightly greater extent of the webs on the fingers in the type are 'trivial'," it would appear that two different species of frogs are involved. Boulenger's statement of color, "pale brown above uniform or with scattered brown dots" suggests that the two forms are present in the type series. The general color and markings of *phlebodes* set it apart very distinctly from *underwoodi*. *Hyla*

FIG. 65. *Hyla underwoodi* Boulenger. Copied from Boulenger, Proc. Zool. Soc. London, 1898, pl. 39, fig. 3; Bebedero, Costa Rica; actual length, 28 mm.

underwoodi Boulenger, *Hyla microcephala* Cope and *Hyla robertmertensi* Taylor are a closely related group of species, and *Hyla phlebodes* with little or no change occurs with them from Costa Rica to Guerrero in Mexico. It is possible that it occurs also in Panamá, but I have not examined specimens from there. Smith (1938) and Smith and Taylor (1948 *loc. cit.*) followed Stuart in placing *phlebodes* as a synonym.

With the acquisition of a series of *phlebodes* from Costa Rica and a comparison with the figure and description of *underwoodi*, I believe there is no question of the distinctness of the two forms in Costa Rica, the type locality of both.

Diagnosis: A small (28 mm.) rather slender frog, the head approximately the width of the body (save in gravid females); fingers one-third webbed; eye length equals snout length; distinct canthus; tympanum length half of eye; toes nearly entirely webbed; pale brown above, uniform or with fine dots or flecks; a dusky stripe from snout tip along side of head and body, usually edged above with lighter color; thighs lacking pigment.

Type description: Tongue circular, slightly nicked, and moderately free behind; vomerine teeth in two small groups between the choanae, as long as the diameter of the orbit; canthus rostralis distinct; loreal region slightly oblique; interorbital space broader than the upper eyelid; tympanum distinct, half the diameter of the eye. Fingers one-third webbed; discs quite as large as the tympanum; subarticular tubercles moderate. The tibiotarsal articulation reaches between eye and tip of snout.

Skin smooth above and on the throat, granular on the [ventral surface of] body. Pale brown above, uniform or with scattered dark brown dots; a dark brown streak on each side of the head and belly, passing through the eye and edged with whitish above; thighs pigmentless; white beneath. Male with a large external vocal sac.

Remarks: The group to which the species belongs includes *Hyla picta* (Günther), *Hyla robertmertensi* Taylor, *Hyla microcephala* Cope, and *Hyla smithi* Boulenger. *Hyla picta,* while strongly allied to the group, lacks vomerine teeth, and these are often absent in younger specimens and perhaps some adults of *Hyla smithi.*

Hyla albomarginata Spix

Hyla albomarginata Spix, Animalia nova sive Species Novae Testudinum et Ranarum quas in Itinere per Brasiliam Annis, 1812, 1820 . . . 1824, 2, p. 33, pl. 8, fig. 1; p. 35, pl. 8, fig. 4 (type locality, Brasil).

Hyla albomarginata Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 356; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Sept. 1901, pp. 284, 285 (San Carlos, C. R.); Dunn, Occ. Papers Mus. Zool. Univ. Mich., No. 151, 1924, pp. 3-4 (tadpoles may be another species *fide* Dunn 1931); Occ. Papers Boston Soc. Nat. Hist., vol. 5, Aug. 1931, p. 401; *idem, ibid.,* Oct. 1931, p. 414; Wettstein, Sitzb. Akad. Wiss. Wien Math.-Natur. Kl., Abt. 1, Bd. 143, Heft. 1 and 2, 1934, p. 8 (Hamburg farm, lower Reventazón River).

Hypsiboas albomarginata Cope, Proc. Amer. Philos. Soc., 1886, vol. 23, p. 273 (Nicaragua, Bransford coll.); U. S. Nat. Mus. Bull., 32, 1887, p. 13.

Diagnosis: This species may be diagnosed by the following characters: rather large species, 45 mm. (reported 60 mm. in Brazilian species), the very light dorsal coloration (yellowish or pinkish in life), whitish flesh with small black dots when preserved;

(dots rarely segregated into small dark spots); concealed parts of limbs without pigment; ventral surfaces whitish; fold on vent and outer edge of foot with a white stripe; at least occasionally a white stripe above tympanum along side of body for some distance; first finger with a well-developed pollex rudiment in the males bearing a sharp exposed spine.

Description of species: Head broad; snout broad and depressed with a somewhat pointed nose, the canthus rostralis indistinct or absent, the loreal region sloping obliquely; a curving fold above tympanum; length of eye greater than its distance from nostril but shorter than snout; tympanum distinct, a little longer than high, its diameter in length of eye one and one-third to one and three-fourths times; the interorbital space much wider than an eyelid; vomerine teeth between the large choanae, in two elongate diverging fasciculi placed somwhat diagonally or curving, extending behind the posterior level of the choanae, a fasciculus a little more than half as large as a choana; tongue relatively small; males with vocal slits; tip of snout rounded in profile, upper lip not notched medially; snout one and four fifths length of eye.

Arm moderate; inner fingers without web, the second one fourth, the fifth, one third webbed; discs on fingers small, not one half size of tympanum. Heel, bearing a soft tubercle or fold, reaches to nostril; toes approximately three fourths webbed, the discs smaller than those on fingers. Skin on dorsum usually rough; finely granular especially so on sides of head; a short anal flap followed by a more or less distinct groove bordered by tubercles; some specialized tubercles or granules at the side of vent; abdomen granular, chest and throat smooth; an incomplete fold across breast.

Color: General color yellowish, punctate with black dots or flecks, these slightly larger on limbs; no pigment on concealed surfaces of limbs or venter; webs on toes bright red or orange; a white line across the anal flap continued (when legs are folded) along the outer edge of leg and foot.

Remarks: I have examined specimens taken on the lower Reventazón River at La Costella but did not take measurements. I have not compared the Costa Rican form here called *Hyla albomarginata* with typical South American material. The larger tympanum, rough or granular skin, the somewhat different arrangement of the vomerine teeth, larger size, etc., suggest that the Central American and Brazilian forms are not identical. The species is known from as far north as Nicaragua. Specimens have been taken in the Lower Reventazón valley, and in San Carlos, Costa Rica.

FAMILY RANIDAE Bonaparte

Ranidae, Bonaparte, Giorn. Accad. Sci. Lett. Arti Roma, vol. 49, 1831, pp. 65, 75.

A single genus, *Rana,* is recognized in the Costa Rican fauna.

Genus RANA Linnaeus

Rana Linnaeus, Systema Natura, ed. 10, vol. 1, 1758, p. 210.

Type of the genus: (*Rana*) *temporaria* Linnaeus.

The five ranid species known from Costa Rica fall into two rather distinctive groups. The first group comprises *Rana pipiens, Rana maculata,* and *Rana palmipes;* the second *Rana vibicaria* and *Rana warschewitschii.* The two latter species seemingly are related to south Asian and East Indian frogs of the genus *Hylorana,* now regarded as a subgenus of *Rana* but very probably worthy of generic rank.

Certain of the species names now referred to the synonymy of the above species may prove to be worthy of recognition when adequate collections are available from their type localities.

KEY TO COSTA RICAN SPECIES OF RANA

1. Body not quadrangular in cross section; tips of toes rather pointed without terminal grooves 2
   Body quadrangular in cross section; tips of toes with or without grooves at tip 3
2. Paired lateral vocal sacs protruding near jaw angle; small puckered vocal openings, open into sacs somewhat behind and lateral to tongue; canthus rostralis rounded; heel to point between nostril and tip of snout; dorsolateral glandular fold broad; choanae large compared to vomerine tooth fasciculi; nostril nearer eye than tip of snout ..... *pipiens*
   No vocal sacs of any kind; no vocal openings in mouth; choanae very small compared to vomerine tooth fasciculi; canthus distinct; eye nearer tip of snout than eye ..... *maculata*
3. Larger frogs, 120 mm.; vocal sacs in males; toes nearly fully webbed with small terminal discs or pads; vocal slits; no light round spots on posterior surface of thigh ..... *palmipes*
   Vocal sacs and vocal openings absent 4
4. Smaller slender frogs, 70 mm.; canthus sharp; snout rather pointed; rounded yellow or white spots on back of thigh; usually red color in groin and on front of thigh; lateral grooves on terminal discs ..... *warschewitschii*
   Somewhat thicker-bodied frogs, 80 mm.; no groove on digit tips; red color often absent; no round white spots on posterior surface of thigh; snout not pointed ..... *vibicaria*

Rana warschewitschii (Schmidt)

Figure 66

Ixalus warschewitschii Schmidt, Sitzungb. k. Akad. Wiss. math.-natur. Cl. Wien, Bd. 24, Heft, 1, 1857, p. 11 (type locality not stated); Denkschr. k. Akad. Wiss. math.-natur. Cl. Wien, Bd. 14, Pt. 2, 1857 (1858) pp. 241-243, pl. 1, fig. 1-4 (type locality, "Unweit des Vulcanes Chiriqui, zwischen 6000 und 7000 höhe, Panama.")

Rana zeteki Barbour, Occ. Papers Boston Soc. Nat. Hist., vol. 5, June 24, 1925, p. 156 (type locality, Barro Colorado Island, Canal Zone).

Rana warschewitschii zeteki Dunn, Occ. Papers Boston Soc. Nat. Hist., vol. 5, Oct. 10, 1931, pp. 416.

Rana warschewitschii warschewitschii Dunn (*loc. cit.*), p. 416.

Rana coeruleopunctata Steindachner, Verhandl. k. k. zool.-bot. Ges. Wien, Bd. 14, 1864, pp. 264-266, pl. 15, figs. 1, 1a-1c ("Fundort unbekannt"); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed. 1882, p. 50, Günther, Biologia Centrali-Americana, 1900, p. 205; Boulenger, Ann. and Mag. Nat. Hist., ser. 9, vol. 3, 1919, p. 412; Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, p. 318; Boulenger, Proc. Amer. Acad. Arts Sci. vol. 55, Aug. 1920, pp. 478-480.

Ranula chrysoprasina Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, pp. 129-130 (type locality "Arriba," Costa Rica); U. S. Nat. Mus. Bull. 32, 1887, p. 19.

Trypheropsis chrysoprasinus Cope, Proc. Acad. Nat. Sci. Philadelphia, 1868, p. 117; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, p. 114, pl. 23, fig. 12.

Rana chrysoprasina Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed. 1882, p. 49.

Hylarana chrysoprasina Brocchi, Étude des Batraciens de l'Amerique Centrale, livr. 2, 1882, p. 65; Steindachner, Novara, Amphib. 1867, p. 48 (not seen).

Diagnosis: A medium-sized, slender ranid reaching 57 mm. in length in females; a sharp canthus rostralis; fingers slightly spatulate at tips without a terminal groove; toes with small distinct, somewhat oval, discs, with grooves on each side of discs, but not passing around the tip; fingers lacking web; first longer than second; no vocal slits or vocal sac; toes approximately two thirds webbed. Sides of head and body nearly vertical; dorsal surface of body and head usually covered with very fine pearly tubercles.

Description of species: (K.U.M.N.H. No. 25009) Head width (15.2 mm.) slightly less than length (16 mm.); canthus rostralis sharp, the edge continued in front of nostril; tip of snout extending slightly beyond lip; head rather pointed, the tip rounded; canthus nearly vertical, not or but slightly concave; nostril lateral, slightly below canthal edge; tympanum oval, diagonally placed, its greatest diameter (4 mm.) approximately two thirds of the eye length (6.1 mm.); the distance of tympanum from eye 1.5 mm.; length of eye equals distance of eye from nostril (4 mm.); length of snout 8.4; choanae lateral, vertically placed, facing inwards; vomerine teeth in two small diagonal fasciculi separated from each other by a distance about equal to that separating them from the choanae;

palatal glands opening nearer anterior level of choanae than to anterior end of palate; tongue relatively large with two posterior projections closely approximated, free for half its length; no vocal slits.

Arm moderate, the wrist not quite reaching tip of snout; first finger a little longer than second; subarticular tubercles distinct; a large inner metacarpal tubercle; palmar tubercle large, divided

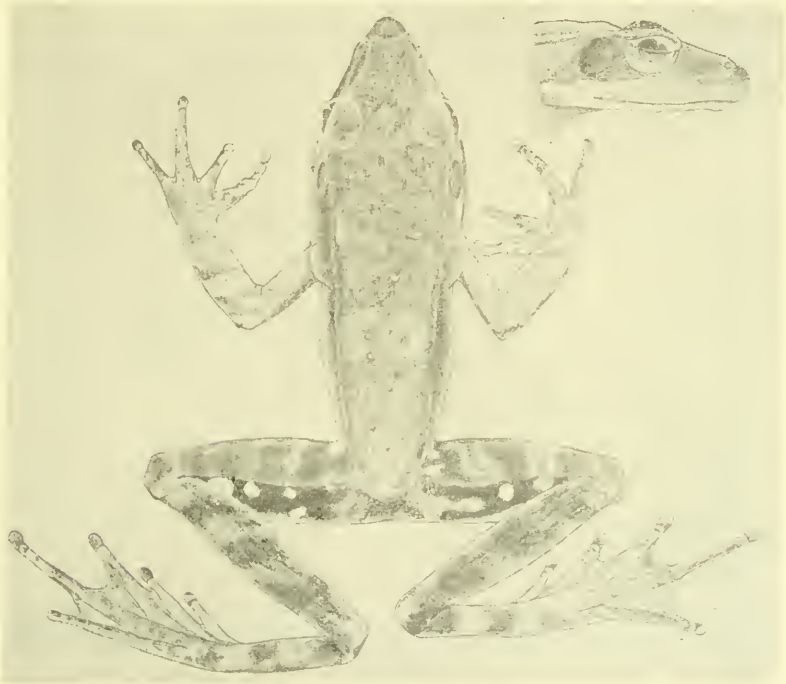

FIG. 66. *Rana warschewitschii* (Schmidt). K.U.M.N.H. No. 25009; 2 mi. SW San Isidro El General, C. R.; actual snout-to-vent length, 46 mm.

the median part largest; legs long, tibiotarsal articulation reaching tip of snout or slightly fails to reach tip. Heels overlap strongly when folded (5.5 mm.). Toes more than two thirds webbed the web reaching discs of all but fourth toe as narrow fringes; a distinct small inner metatarsal tubercle and a much smaller outer tubercle; no distinct tarsal fold, but an elongate, scarcely discernible, tarsal gland or swelling extends length of tarsus.

Skin on dorsal surface of body and head with very numerous pearly tubercles and a few larger tubercles scattered on back and on the two dorsolateral glandular folds; tubercles on dorsal surface

of tibia arranged in longitudinal rows; much of the under surface of thigh and area below vent on posterior surfaces with smooth granules; venter, chin and throat smooth.

Color: Above and on sides brown, the dorsolateral lines, due to the tiny pearly granules appearing slightly whitish; legs above brownish, barred with blackish brown, the bars extending down on the anterior surface of thigh; posterior surface black enclosing rounded light cream spots. Under surface of hand and foot yellowish; venter grayish white, upper lip cream.

Measurements in mm.: (No. 25009 San Isidro El General, on Pacific slope). Snout to vent, 46; width of head, 15.2; length of head, 16; length of eye, 6.1; diameter of tympanum, 4; length of snout, 8.4; arm, 28; hand, 12.7; leg, 74.5; tibia, 25.5; foot and tarsus, 36.

Remarks: The variation is considerable, or there are subspecies to be considered. In the material available to me there is a series of specimens from Los Diamantes, in which all the specimens have the sides of the body deep brown, while the dorsal surface is distinctly lighter brown. The cream-white streak begins under eye and continues back to arm insertion. This lies above the lighter coloration of the upper jaw edge.

A series from near Turrialba, (Morehouse Finca 4 mi. south and La Suiza, 4 to 6 miles southwest) are similar, but most of the specimens have the sides rather lighter brown than the back, although an occasional specimen has the darker brown sides. The coloration in life of such a specimen from La Suiza (R.C.T. No. 246) is as follows: above olive brown the sides uniform dark brown, arms light flesh to clay, the hand and the limbs darker, barred with darker color; a cream-yellow line on lip with a whitish line from below eye to arm insertion paralleling the former; groin red with some yellow spots; posterior thigh black with deep orange irregular spots; under side of thigh very bright orange-red extending on under side of tibia and foot; front of thigh yellowish cream flecked with red, and a dark knee spot; chin sulphur to greenish yellow with some flecks or red reticulation under arm and hand.

The elevation of the La Suiza locality is 2500 ft. more or less. A specimen taken at Isla Bonita on Volcán Poás differs very markedly from other specimens taken in the same locality. It is uniform deep bluish black, the skin lacking all trace of the fine pearl-tipped granules. The leg in life was somewhat red on the under surfaces while the two or three small spots on the black posterior

face of the thigh were yellow. The under surface of the chin, anterior two thirds of venter and anterior third of ventral part of thigh was strongly clouded with grayish black. The spot at the front point of arm insertion is well defined. The under surface of the hand and foot is blackish, with some yellowish areas. This specimen is a male with a large nuptial gland on first finger. Traces of the leg bands are visible only on the front face of the thigh. The snout-to-vent measurement is 52 mm.

A second specimen, also a male, lacks the pearly tubercles but the skin is finely corrugated or pebbled with smooth granules. It is olive brown on the dorsum and sides and the banding on the legs is distinct. The ventral surfaces are less distinctly mottled, and the white line from the eye to the arm is distinct.

A total of 54 specimens have been examined from Costa Rica. Aside from localities already mentioned is one specimen from Cartago and several from Los Diamantes near Guápiles. The species has been reported from Suretka and Navarro.

Rana zeteki, which has been regarded as a subspecies of this species, is described as follows: "A Rana closely related to *Rana warschewitschii* (Schmidt) = *Rana caerulopunctata* [*sic.*] (auct.) and differing conspicuously in having a wholly black throat, chest and upper belly instead of an ashy-gray venter; dark, not pink, anterior aspects of the thighs; inconspicuously instead of heavily cross-barred tibia; the white stripe on the upper lip extending to beneath the eye instead of to the tip of the snout; the dorsum much less coarsely granular; the feet and webs largely black instead of largely coral pink; a distinctly shorter hind leg and more massive thigh." The type is No. 10031 M.C.Z. from Barro Colorado Island, Gatun Lake, Canal Zone (four paratypes).

Rana coeruleopunctata Steindachner* is a species described in a work dealing with species from many localities. The type locality of this species is not known ("Fundort unbekannt"). Whether or not this species actually originated in Central America has not been decided beyond question. The description is detailed and a reasonably good figure is given. Certain characters given by Steindachner for the form, differ from those in specimens I have before me from Costa Rica, probably the most significant being, the bluegreen spotting on the dorsal surface of the body. This is distinct and extensive as shown in the figure.

* Steindachner, Verhandl. k. k. zool.-bot. Ges. Wien, Bd. 14, 1864, pp. 264-266 pl. 15, fig. 1, 1a, 1b. 1c

Rana vibicaria (Cope)

Figure 67

Levirana vibicaria Cope, Proc. Amer. Philos. Soc. Philadelphia, 1894, p. 197 (type locality "Rancho Redondo, on the divide of the Irazú range"; "Isla Nueva near the head of the Río Sucio on the Atlantic side. G. K. Cherrie coll.); Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb., 1900, p. 206.

? *Rana godmani* Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, p. 204, pl. 63, fig. a and a'. (type locality Río Sucio, Costa Rica, Underwood coll.); Boulenger, Ann. Mag. Nat. Hist., ser. 9, vol. 3, 1919, p. 411; and Proc. Amer. Acad. Arts Sci., vol. 55, No. 9, 1920, pp. 462-464.

Rana vibicaria Dunn, Proc. Biol. Soc. Washington, vol. 35, 1922, pp. 221-222, (Crater, Volcán Poás).

Diagnosis: A moderately large, slender-bodied frog measuring 70 mm. snout to vent. Snout short, wide with a sharp canthus rostralis angulated at nostril, which is nearly on the canthus; tympanum rounded, its diameter seven tenths of the length of eye opening; sides of body and head vertical; tongue deeply notched behind; slight terminal swelling on tips of toes; first finger shorter than second; toes half webbed; a thick dorsolateral glandular fold; no dermal folds or tubercles; ventral surface of body yellowish.

Description of the species: Rather large ranids, the head as wide as or a little wider than the body, but width distinctly less than head length; canthus rostralis distinct, rounded on edge, curving from eye to nostril; in front of nostril snout rather long, deflected down a little, presenting a flattened triangular area immediately in front of nostrils; tip of snout, in profile, rounded to lip, projecting distinctly beyond lip for two millimeters; loreal region somewhat concave, the upper face vertical the lower sloping obliquely to lip; tympanum large, in younger specimens its diameter about one half length of eye; in large females "tympanum nearly size of eye," length of eye greater than its distance from nostril but shorter than the length of snout; nostril approximately midway between eye and tip of snout; width of an eyelid equal to the interorbital width; a continuous dorsolateral glandular fold from eye to near end of rump; a small narrow supratemporal fold branching from it and passing diagonally down behind tympanum.

Tongue lanceolate deeply emarginate posteriorly, forming two rounded projections; vomerine teeth in two oblique series between choanae, which are about size of a tooth fasciculus.

Arm rather long the wrist reaching tip of snout; tips of fingers not or slightly swollen, the first distinctly longer than second, minutely shorter than fourth; proximal subarticular tubercles distinct; inner metacarpal tubercle elongate, palmar tubercle distinct,

FIG. 67. *Rana vibicaria* (Cope). Figure (*Rana godmani*) copied from Günther, Biologia Centrali-Americana; Reptilia and Batrachia, 1900, pl. 63, fig. a and a[1]; Río Sucio, Costa Rica; probably about natural size.

partly divided; no trace of webbing, and none or but slight ridges on sides of fingers; heel to a point just anterior to eye, when legs are placed at right angles to body heels touch or barely overlap; tips of toes with flattened pads, lacking terminal grooves; first toes less than half webbed; between second and third the web reaches two thirds length of second; between third and fourth the web is three fifths length of third; between fourth and fifth web reaches two thirds length of the fifth toe; the web however on all toes continued as a strong fringe to pads; an elongate inner metatarsal tubercle, a small rounded outer tubercle; no distinct tarsal fold, but a thickened tarsal ridge, the individual glandules usually visible through skin.

Skin smooth, above and below save for a few scattered pustules on dorsum, and a granular area on the mesial posteroventral part of thigh. Vent high, followed by a groove bordered by two indefinite folds.

Measurements in mm. of Rana vibicaria (type series after Boulenger, loc. cit.)

	♂	♀	♀
Snout to vent	56	80	74
Width of head	20	26	25
Length of head	19	25	23
Length of snout	7	10	9
Eye length	7	9	8
Tympanum	4	5	5.5
Interorbital width	3.5	5.5	6
Arm	35	51	43
Leg	87	122	113
Tibia	26	38	34
Foot and tarsus	27	41	37

Variation: The color above is variable; it may be brown or orange above, with or without black spots and flecks; the first finger of the males does not show the usual secondary sex characters. The measurements given by Boulenger (*loc. cit.*) differ somewhat from those of Günther (*loc. cit.*). The smallest specimen of three is regarded as a female by Günther, as a male by Boulenger.

Remarks: A series of specimens of this species was obtained at the summit of the ridge lying between Volcán Barba and Volcán Poás. A number of the specimens are recently transformed.

The synonymizing of *Rana godmani* Günther and *Levirana vibicaria* Cope was suggested by Boulenger (*loc. cit.*). The differences nevertheless are marked and may be listed as follows:

	godmani	*vibicaria*
1.	First finger shorter than second	Longer than second.
2.	Muzzle short and wide, not projecting beyond lip border	Muzzle rather elongate, feebly projecting beyond mouth.
3.	Vomerine teeth absent	Vomerine teeth in oblique groups.
4.	Sole of foot with one inner tubercle.	Sole with an inner and outer metatarsal tubercle.
5.	Integument smooth	Some dorsal tubercles.
6.	Two rows of black spots	Spots scattered on back.
7.	Lips with a shaded dark border	Lips with a white or silvery stripe.
8.	Head wider than long	Head longer than wide.

It is possible that two species actually are present in Costa Rica. Future collections will prove the facts beyond question. I am following Boulenger in my treatment here.

Rana pipiens Schreber

Rana pipiens Schreber, Der Naturforscher, Halle, vol. 18, 1782, p. 185, pl. 4, (type locality, Raccoon, Gloucester Co., New Jersey, U.S.A.); Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 203-213, figs. 1a, 24; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, p. 98; Wettstein, Sitzungsb. Akad. Wiss. Wien, math.-naturw. Kl. Abt. 1, Bd. 143, Heft. 1/2, 1934, p. 4-5 (Finca Guayabillos, 2200 m. on Volcán Irazú, Costa Rica).

Rana halecina Daudin, Histoire naturelle des rainettes, des grenouilles et des crapauds 1803, p. 41; Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum 2nd ed., 1882, p. 41; Cope, U. S. Nat. Mus. Bull. 32, 1887, p. 19 (*part.*); Günther, Biologia, Centrali-Americana; Reptilia and Batrachia, Feb. 1900, p. 198; Boulenger, Proc. Amer. Acad. Arts and Sci., vol. 55, no. 9, Aug. 1920, p. 433-434. (*part.*).

R[ana] v[irescens] austricola Cope, U. S. Nat. Mus. Bull. 34, 1889, pp. 398-399 (Mexico); Werner, Verh. k. k. zool.-bot. Gesells. Wien, Jahrg. 1896, p. 7.

Rana austricola Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, p. 315, pl. 15, fig. 1 (Nicaragua).

? Rana macroglossa Brocchi, Bull. Soc. Philom. ser. 7, vol. 1, no. 4, p. 177 (type locality, plateau of Guatemala). Brocchi, Étude des Batraciens de l'Amerique Centrale; Mission Scientifique au Mexique . . . livr. 1, 1882, p. 12, pl. 3, fig. 1-1c [I am not certain that this species should be placed in the synonymy of *Rana pipiens*].

Diagnosis: Large frogs, 80 mm. snout to vent; vomerine teeth in two fasciculi, closer to each other than to choanae, between posterior half of choanae; eye about equal to snout-length; a pair of broad dorsolateral folds extending from eye to groin but usually broken on rump; belly very feebly granulate; latter half of thighs more distinctly granulate; toes obtusely pointed more than two-thirds webbed; tarsal fold weak; strong inner metatarsal tubercles; outer small indistinct; heel reaching to between eye and tip of snout; body olive to gray, spotted strongly with black; below immaculate.

Description of species: (K.U.M.N.H. No. 121); Head elongate

oval, its length (31 mm.) distinctly greater than its width (29 mm.); eye large its length (10 mm.) greater than its distance from nostril (6.8 mm.); nostril nearer eye than tip of snout; tympanum large subcircular, its diameter (7.3 mm.) approximately three fourths of eye length; canthus distinct but rounded; nostrils swollen but with none or but a slight depression between them; upper edge of loreal region vertical, lower part sloping obliquely to lip, leaving loreal region concave; tip of snout curving from nostrils down to lip, barely extending beyond mouth; width of an eyelid (6 mm.) greater than interorbital width (4 mm.).

Tongue somewhat arrow-shaped, deeply notched, leaving two mammae-like projections posteriorly; fasciculi of vomerine teeth diagonally placed between choanae, separated from each other by a distance half as great as that separating them from choanae; vocal sacs external, posterior to angle of jaw; the small, puckered, lateral vocal openings are far back in the mouth; jaw thickened, forming an indistinct ledge below eye; an elongate glandular fold from angle of jaw to above arm; a broad dorsolateral fold on ridge from eye to end of rump usually broken behind sacrum; a few short ridges and tubercles between dorsolateral folds.

Arm rather short the wrist reaching tip of snout; first finger longer than second (much thickened at base in males), a large elongate flattened inner metacarpal tubercle at base of first finger; a large irregular, flat palmar tubercle; subarticular tubercles distinct rather low; one, two or no supernumerary tubercles; male with a large nuptial gland on base and dorsal part of first finger; toes narrowed, but rounded at tips; trace of dermal ridges on inner sides of fingers two and three.

Leg rather long, the heel reaching to nostril (sometimes to tip of snout in younger specimens); toes three-fourths to four-fifths webbed the web notched or emarginate between toes. A large metatarsal tubercle at the base of first toe, its edge compressed, free; no outer tubercle; a slight tarsal ridge on inner side of tarsus and a similar ridge indicated on outer side; subarticular tubercles elongate, slightly compressed.

Skin above rather rough with wrinkles and tubercles; two indistinct tubercular rows from sacrum meet at end of urostyle; sides finely wrinkled, with a few tubercles near the dorsolateral line; ventral surfaces smooth with a wrinkle or fold across breast; much of the posterior face of thigh and part of the ventral face with fine granules; under a lens some of these appear to be capped with a fine pearl tip.

Color: Olive above in life (brownish gray in preservative); back with two rows of dark brown spots somewhat diffuse anteriorly, discrete posteriorly; a canthal mark; two lateral rows of black spots; legs and arms with darker transverse bands with a longitudinal dark mark on left tibia; back face of femur dull yellowish brown, with heavy dark reticulation; a black mark on front of upper arm; a canthal black streak continued behind eye above tympanum. Venter and under side of limbs immaculate; under surface of foot and hands grayish.

Measurements in mm.: Snout to vent, 80; length of head, 31; width of head, 29; diameter of tympanum, 7.2; length of eye, 10.3; length of snout, 14; arm, 50; hand, 21; leg, 134; tibia, 45; foot and tarsus, 66.

Remarks: All specimens are brownish olive with black spots on dorsum in two to four rows. The vomerine teeth are variable; sometimes arranged diagonally, converging toward the median line; sometimes the groups are practically transverse. The size of the groups varies. Some are no larger than the choanae, others are one and one-half times the size of the choana; the proportional size of the choanae vary but little. The ventral coloration is similar in all.

The subspecific forms of *Rana pipiens* are not considered here. It is very difficult to find sufficient fixed characters to distinguish this form from its near relatives in Mexico and elsewhere. The form has been distinguished under the name *R. austricola.*

Rana maculata Brocchi

Rana maculata Brocchi, Bull. Soc. Philom. ser. 7, vol. 1, No. 4, p. 178 (type locality Totonicapam Guatemala); Étude des Batraciens de l'Amérique Centrale, Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 1, 1881, p. 13, pl. 3, figs. 2, 2c.
Rana vivescens austricola Werner, Verh. k. k. zool.-bot. Gesells, Wien, Jahrg. 1896, p. 7 (*part.*).
Rana pipiens Kellogg, U. S. Nat. Bull. 160, 1932, pp. 203-213 (*part.*).
Rana halecina Boulenger, Proc. Amer. Acad. Arts Sci., vol. 55, No. 9, Aug. 1920, pp. 433-443, (*part.*).

The presence of a frog on the Caribbean side of Costa Rica related to *Rana pipiens* but differing from it specificially is attested to by three specimens from Peralta, Costa Rica. Superficially they would seem to belong to *Rana pipiens* but their general habitus, details of coloration, the absence of the lateral vocal sacs in the male as well as the absence of the small, puckered, vocal perforations far back in the mouth near the jaw angles, all prove the presence of a distinct species. Occurring also in Costa Rica

is a species much more frequently encountered that does belong to the *Rana pipiens* complex. Specimens of the latter species were taken above Isla Bonita (7500 ft.) Volcán Poás at Turrialba, Cartago. Moravia and at San Isidro on the Pacific lowland.

By direct comparisons of two specimens one of *maculata* and a specimen of *pipiens* from Turrialba the following structural differences are discernible:

1. Diameter of choanae in distance between, 7-8 times	1. Approximately 4 times
2. Vomerine tooth fasciculus 8 times size of choana	2. 1½ times
3. Palatal groove midway between vomerine teeth and end of palate or nearer the teeth	3. Nearer anterior end of palate
4. No vocal opening or external sac	4. Vocal openings and external sac
5. Ridge on inner side of 2 and 3 finger	5. Less distinct
6. Hand and foot smaller	6. Hand and foot larger

Diagnosis: Related to *Rana pipiens* but differing in having very small choanae several times smaller than vomerine tooth groups; absence of vocal slits or openings; smaller hands; mottled or spotted ventral coloration; posterior face of thighs black, with white dots or vermiculations.

Description of species: (From K.U.M.N.H. No. 2978 Collected by Marco Tullio Pacheco, at Peralta C. R.) Snout to vent 75 mm.; width of head (27 mm.) approximately equal to length (26.8 mm.); canthus rostralis distinct to nostril and some angularity evident anterior to nostrils; latter nearer eye than tip of snout; areas about nostrils not or but slightly swollen; tympanum diameter (6.5 mm.) approximately three fourth eye length (8.3 mm.); length of snout 11 mm.; snout oval, in profile sloping to lip; upper loreal region vertical somewhat concave, lower part sloping obliquely to lip edge, the skin on jaw seemingly thickened and continued under tympanum to behind jaw angle as a continuous skinfold; a dorsolateral glandular fold from eye to behind sacrum followed in line by some elongate tubercles; a branch from this fold runs down diagonally behind the tympanum almost contiguous with the fold from upper jaw; eyelid wider than interorbital interval; tongue somewhat cordiform with two rather widely separated posterior horns, and free for half its length; vomerine teeth in two large transverse fasciculi separated from the tiny choanae by one third length of one fasciculus and from each other by less than half that distance;

diameter of choanae in distance between them approximately 8 times; (male without vocal slits or openings).

Arm rather slender, the skin shining smooth; first finger longer than second; an elongate flat inner metatarsal tubercle; dorsal part of first finger with a nuptial area (not unlike that in male) covered with fine nuptial asperities; subarticular tubercles distinct; three supernumerary tubercles on palm; two large palmar tubercles the inner rounded somewhat the outer elongate; trace of lateral ridges on fingers; more pronounced on inner edges of second and third fingers.

Legs rather short, the end of heel reaching the tip of snout; a light-colored tarsal fold or ridge present; inner metatarsal tubercle compressed with a free edge; toes four-fifths webbed the web somewhat emarginate between toes; no outer metatarsal tubercle; subarticular tubercles elongate, compressed.

Skin generally smooth with some dorsal irregular ridges between dorsolateral lines; a few irregular tubercles on sides; venter smooth, lower part of posterior face and posterior part of ventral face of thigh very finely granular, the granules each with a minute pearly tip; vent opens at upper level of thigh; dorsal surface of tibia and tarsus and area lateral to and above vent with minute pearly spinules.

Color: In preservation dark brown, with two series of rather large spots on dorsum, the first pair smallest on inner part of eyelid; sides with two rows of spots the ground color growing lighter low on side; venter dirty white with numerous gray-black or black flecks, or marbling, on chin, breast, and under side of arms and legs. Under surface of hands and feet black; a black loreal line continued behind eye; upper surface of arm and leg dark with black spots; posterior face of thigh deep black with small white or light lavender spots or vermiculations.

Measurements in mm.: Snout to vent, 75; length of head, 26.8; width of head, 27; length of snout, 11; diameter of tympanum, 6.5; length of eye, 8.3; arm, 43; hand, 17; leg, 125; tibia, 42; foot, 41; tarsus, 21.

Remarks: The three specimens of this form are all from Peralta, collected by Prof. Marco Tulio Pacheco and presented to the Museum Collection.

Whether this is actually identical with Brocchi's *maculata* cannot be determined until the type is re-examined critically.

Rana palmipes Spix

Rana palmipes Spix, Animalia Nova, sive species novae testudinum et ranarum quas in itinere per Brasiliam . . . . . 1824, p. 5, pl. 5, fig. 1. (type locality, Brazil); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Mus., p. 48; Ann. and Mag. Nat. Hist., ser. 6, vol. 2, 1888, p. 40; *idem*, vol. 8, 1891, p. 453; Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 19; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 202-203. (México; Verapaz, Guatemala; northern parts of tropical America); Noble, Bull. Amer. Mus. Nat. Hist., vol. 38, 1918, p. 316, pl. 14; Kellogg, U. S. Nat. Mus. Bull. 160, 1932, pp. 200-202; Boulenger, Proc. Amer. Acad. Arts Sci., vol. 55, No. 9, Aug. 1920, pp. 473-477; Smith and Taylor, U. S. Nat. Mus. Bull. 194, 1948, pp. 98-99.

Ranula brevipalmata Cope, Proc. Acad. Nat. Sci. Philadelphia, 1874, p. 131; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1870, p. 114 (Pico Blanco, C.R.)

Rana vallianti Brocchi, Bull. Soc. Philom., ser. 7, vol. 1, 1877, p. 175. Mission Scientifique au Mexique et dans l'Amérique Centrale; Étude des Batraciens de l'Amérique Centrale, livr. 1, 1882, p. 11, pl. 2. (type locality, Mullins River near Belize, British Honduras).

Rana melanosoma Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 203-204, pl. 63, fig. B (*fide* Boulenger); (type locality, Dueñas, Guatemala, and Hacienda Rosa de Jéricho, 3250 ft. Nicaragua).

Diagnosis: A large frog, snout to vent 110 mm.; vomerine teeth in small oblique groups equally spaced between the posterior borders of choanae; eye large, very prominent; heel to a point between eye and snout tip; toes with small terminal discs, usually nearly fully webbed; no tarsal fold; inner metatarsal tubercle elliptic; no outer tubercle present; males with vocal slits; a glandular dorsolateral fold from eye to near femur; belly smooth. In life, anteriorly greenish, the body brownish or grayish posteriorly.

Description of species: (R.C.T. No. 78 from Turrialba, C. R.) Body elongate, the head oval, wider than body, its length (44 mm.) greater than its width (39 mm.); tympanum large, (10 x 8.5 mm.) the greatest diameter diagonal; length of eye (12 mm.) slightly greater than distance from nostril (10 mm.), shorter than snout (16 mm.); canthus rostralis distinct, rounded, the loreal region concave; nostrils on line of canthus, prominent; a slight, broad, medial, longitudinal depression on snout, continued to between nostrils; upper part of loreal region nearly vertical, lower part sloping obliquely to lip; upper jaw thick, somewhat elevated; width of an eyelid approximately equal to interorbital width; nostril closer to eye than to median point on upper lip; snout projecting slightly.

Choanae transverse; vomerine teeth in two diagonal fasciculi, situated between and extending slightly behind choanae, separated from each other by a distance equal to that separating them from choanae; tongue arrow-shaped, deeply notched behind between

two long projections. (No trace of vocal sac or vocal slits in males).

Arm moderately slender, the wrist barely reaching tip of snout; fingers slender, very slightly swollen at tips; first finger a little longer than second, about equal in length to fourth, thickened at its base by the inner metacarpal tubercle; palmar tubercles obsolete or small; no web on hand but distinct lateral ridges on each digit; heel reaches anterior edge of eye; when legs are folded at right angles to body, the heels touch or barely overlap; tips of toes swollen and somewhat dilated at tip; toes fully webbed; a small inner metatarsal tubercle; outer metatarsal tubercle obsolete; distinct fringe or fold on outer edge of fifth and inner edge of first toe; subarticular tubercles distinct; a tarsal ridge, somewhat rounded.

Skin above with a pair of dorsolateral glandular folds extending from orbit to near groin (often continued to end of body), none or the merest trace of a posttympanic fold; back with very minute pearly-tipped spinules intermixed with larger similar tubercles; tubercles on tibia tending to form three longitudinal lines; ventral surfaces smooth (or in males with very numerous fine tubercles); an area of indistinct granulation below vent; anal flap very short, the vent high, on dorsal level of thigh.

Color: Anterior part of body greenish especially on head and shoulders; brownish or bronze on the posterior part of body and on limbs; dorsolateral fold colored like body; numerous small flecks of black on dorsum; sides gray or gray-brown with numerous rounded black spots; posterior aspect of thigh black, reticulated with cream; legs indistinctly barred with darker; under surface dirty yellowish white, somewhat clouded with darker; under side of foot dusky.

Measurements in mm.: (from R.C.T. No. 78 ♀.) Snout to vent, 114; width of head, 39; length of head, 44; tympanum, 10 x 8.5; length of snout, 16; arm, 58; hand, 27; leg, 162; tibia, 53; foot and tarsus, 76.

Remarks: This large species was found at Turrialba in a small artificial lake on the grounds of the Inter-American Institute of Agriculture. Here it was common. Specimens were taken also at Moravia in a small pond.

FAMILY MICROHYLIDAE Parker

Microhylidae Parker, Monograph of the Frogs of the Family Microhylidae, London, 1934, p. 19.

The family Microhylidae, comprising the narrow-mouthed toads, a group specialized largely for burrowing, is rather meagerly represented in North America; only two genera, *Microhyla* and *Hypo-*

pachus, being recognized north of Panamá. Five other genera occur in South America.

Both genera are represented in Costa Rica and both are rather widespread in the Western Hemisphere. *Hypopachus* is known from Texas southward through Mexico and Central America to South America where it extends to Bolivia, Paraguay and Brazil. The greatest amount of speciation in the genus seems to have taken place in southern Mexico and northern Central America. *Microhyla,* as now interpreted, has representatives in the Western Hemisphere from Nebraska and southeastern United States, south into Mexico and Central America; in South America it reaches Ecuador and southern Brazil. The genus likewise occurs in South Asia.

Until Parker's 1934 revision of the Family Microhylidae appeared, a third genus, *Glossostoma,* was recognized for the species *aterrimum;* but Parker has shown that it is merely a large species of *Microhyla* and the most primitive of the American forms of that genus.

Microhyla pictiventris, known from Nicaragua, a small (22.5 mm. long) species characterized by a black venter bearing large cream spots, is reported by Dunn (1949) from Costa Rica (Atlantic lowlands without specific locality).

The Microhylid frogs are largely burrowing, and while rarely seen may be recognized by their call, a "baa-a-a" which is characteristically reminiscent of the call of sheep and goats, though lacking the force of the call of those animals.

The heads of these amphibians are very small in proportion to the size of the body and the snout is much reduced. The metatarsal tubercles on the feet are enlarged and seem to be adapted for burrowing.

Genus HYPOPACHUS Keferstein

Hypopachus Keferstein, Nachricht. könig. Ges. Wiss. Georg-Augusts Univ. Göttingen, 1867, p. 352.

Type of genus: *Hypopachus seebachii* Keferstein [= *Engystoma variolosum* Cope].

Hypopachus variolosus (Cope)

Figure 68

Engystoma variolosum Cope, Proc. Acad. Nat. Sci. Philadelphia, 1866, p. 131 (type locality, "Arriba," Costa Rica, Chas. N. Riotte, coll.); Brocchi, Bull. Soc. Philom., Paris, ser. 7, vol. 1, p. 192.

Systoma variolosum Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, 1867, p. 194.

Hypopachus seebachii Keferstein, Nachricht. königl. Gesell. Wiss. Georg-Augusts Univ. Göttingen, 1867, p. 352 (body length, 48 mm. including head,

6 mm.; body breadth, 35 mm.; leg, 50 mm.; arm, 25 mm. Costa Rica.); Arch. für Naturg., Jahrb. 34, vol. 1, 1868, p. 293, pl. 9, figs. 1, 2 (lateral view, and pectoral girdle).

Hypopachus variolosus Cope, Proc. Amer. Philos. Soc., vol. 11, 1869, pp. 166-167; Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 8, 1875, pp. 101; Brocchi, Étude des Batraciens de l'Amérique Centrale; Mission Scientifique au Mexique et dans l'Amérique Centrale, livr. 2, 1882, pp. 92-93, pl. x, fig. 2 (probably only *part.*); Boulenger, Catalogue of the Batrachia Salientia s. Ecaudata in the collection of the British Museum, 2nd ed., 1882, p. 159; Cope, U. S. Nat. Mus. Bull. No. 32, 1887, p. 18; Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, p. 211 (*part.*) (Bebedero, and San José, Costa Rica; Mexican references are to other species); Nieden, Das Tierreich, Lief. 49, Anura II, p. 70, (*part.*); Mirando-Ribeiro, Arch. Mus. Nac. Río de Janeiro, vol. 27, pp. 191, 226, fig. 102; Kellogg, U. S. Nat. Mus. Bull. No. 159, 1932, p. 184 (*part.*); Parker, Monograph of the Frogs of the Family Microhylidae, 1934, London, pp. 112-113 (All specimens known from Costa Rica listed); Dunn, Amer. Mus. Novitates No. 1419, May 9, 1949, p. 3.

Diagnosis: A fat, triangular body; snout extremely short; eye very small; mouth narrow; fingers without web; feet narrow with a web remnant; two large prominent metatarsal tubercles; above lavender to brown, mottled or spotted black; a dark lateral stripe; belly blackish with rounded cream spots; a light diagonal line from eye to insertion of arm; tympanum not visible; no vomerine, or jaw teeth.

Description of species: (K.U.M.N.H. No. 28338.) Head small, triangular, its width at tympanic region (8 mm.) about equal to its length (7.6 mm.); eye small, its length 3.2 mm.; snout length 4.3 mm.; eye to nostril 2.3 mm.; width of an upper eyelid (2.3 mm.) in interorbital distance (4.6 mm.) twice; tip of snout rounded extending slightly beyond mouth, and in lateral profile slopes sharply back to lip; a deep groove from eye to arm insertion; a groove crossing back end of jaw can be traced some distance across chin. Tongue broader anteriorly than posteriorly, longer than broad, free, save at its anterior end; no teeth; posterior part of choanae visible when seen from below, the remainder concealed by an overhanging shelf; a broad fleshy elevation on palate in front of oesophagus, the surface longitudinally grooved; preceding this is a narrow fleshy fold, its transverse length three to four times its width, the ends slightly free.

Arm short, fingers free, the first distinctly shorter than second; subarticular tubercles low but distinct; outer palmar tubercle largest, that at base of first finger smallest; tips of fingers not or minutely widened, the fingers rounded without trace of lateral ridges; legs very short, the toes webbed at the base (about $\frac{1}{4}$ to $\frac{1}{5}$); inner toe very short; fifth shorter than third; the tips of all digits slightly narrowed and swollen on under surface of tip; subarticular tubercles

distinct; no supernumerary tubercles on either hands or feet; inner metatarsal tubercle large, elevated, about 3 mm. long at its base, and 1 mm. high; outer tubercle smaller, a little less than 2 mm. wide at base, the two separated by about 1 mm., no tarsal ridges or tubercles.

FIG. 68. *Hypopachus variolosus* (Cope). K.U.M.N.H. No. 28338; Cartago, Costa Rica; actual snout-to-vent length, 45 mm.

Skin of back thick, leathery, generally smooth, as is entire venter; region surrounding anal opening with numerous minute, spiny, pearl-tipped pustules; under a lens a few smaller pearl-tipped pustules are visible on tibia, on rump and in groin.

Color: Dorsal surface purplish or lavender-brown; a large irregular black spot in groin with an irregular broken stripe, extending

foward on back, often reaching shoulders; a diagonal dark stripe on side of head continuing above arm to groin area; bordering this above is a broad irregular stripe, lighter than remainder of dorsum; chin and throat brown to lavender; belly dark with large cream spots, often rounded; a diagonal light line from eye to arm; a black bar across folded limbs.

Measurements in mm.: (K.U.M.N.H. No. 2473.) Snout to vent length, 45; head width, 8; head length, 7.6; arm and hand, 23.7; leg, 50; tibia, 16; tarsus and foot, 27.

Variation: Certain of the specimens show a few large pustules on the back while the entire surface is covered with minute pearly tubercles. The males are light chocolate-brown above and the pearly pustules are stronger and larger, visible to the naked eye. Pustules likewise are strongly developed over the lower jaw and lip with a few bordering the upper lip. Males are lighter than females on the belly and on the anterior part of the venter. The subcircular disc on the venter is more or less defined (used in clasping) but it is seemingly entirely absent in females. The feet of the males are about half webbed, but the webbing is irregular. A scalloped fringe extends to near the tip of the fourth toe. (Males however differ among themselves in respect to the amount of webbing.) An ample, vocal sac is present in males, the vocal slits in the mouth being very large. The external skin of the vocal sac is blackish. Occasional specimens show a groove or a slight fold across head just back of orbits.

The relationship of this species is not well known. Several forms are recognized in northern Central America and Mexico. The genus also has representatives in South America.

Specimens of this species were captured along the wet streets in the environs of Cartago, Costa Rica, in small water pools after a rain. The males were calling, the voice resembling the "*baa*" of a sheep. Females were collected but no pairs were found clasping. When approached the animals sank under the surface of the water to the bottom where for a time they remained motionless.

Genus MICROHYLA Tschudi

Microhyla Tschudi, Mem. Soc. Sci. Neuchâtel, vol. 2, 1939, pp. 28, 71.

Type of genus: *Hylaplesia achatina* Boie (*nomen nudum*) [= *Microhyla achatina* Tschudi].

Two species are reported as occurring in Costa Rica. One *Microhyla aterrima* is the largest species of the genus (55 mm.); the other is diminutive the type measuring 22.5 mm.

KEY TO COSTA RICAN MICROHYLA

Larger. Color gray black to black above and below lacking white marks on ventral surfaces ..... *aterrima*

Smaller. Olivaceous brown above; a black band with a pale superior border from muzzle to lower part of groin; below black with large white spots on venter, and smaller white spots under hind limbs ..... *pictiventris*

Microhyla aterrima (Günther)

Figure 69

Glossostoma aterrimum Günther, Biologia Centrali-Americana; Reptilia and Batrachia, Feb. 1900, pp. 210-211, pl. 64, fig. A (type locality, Costa Rica; British Mus. No. 1902.5.12.6♀; Underwood, collector); Nieden, Das Tierreich, Lief. 46, Anura II, Sept. 1926, pp. 68-69, fig. 45 (outline drawing of Günther's figure).

Gastrophryne aterrima Parker, Occ. Papers Mus. Zool. Univ. Michigan, no. 187, 1927, p. 5.

Microhyla aterrima Parker, A Monograph of the Frogs of the Family Microhylidae, 1934, pp. 143-144 (Peña Lisa, Colombia, 300 ft. and Río Durango, northwest Ecuador); Dunn, Amer. Mus. Novitates, no. 1419, May 9, 1949, pp. 16-17 (Carillo, Atlantic lowlands of Costa Rica; Muzo, 840 m. elevation, in "the middle Magdelena forest," Dept. Boyacá, Colombia. Incorrectly gives the date, 1902 as the date of the type description).

Diagnosis: Snout rather narrowed, rounded at tip, one and two thirds as long as eye; skin of head and dorsal surface appearing smooth; eyes small, the width of an eyelid in interorbital distance 2½ to 2¾ times; no canthus rostralis; numerous minute pearly tubercles on upper lip, the outer parts of chin, on arm, hand, foot and on posterior part of tibia; limbs short, the tibiotarsal articulation reaching to a point some distance behind tympanic region; tympanum not visible; fingers short, free of web; foot less than one half webbed. Color black above, dark grayish below.

Description of species: (from K.U.M.N.H. No. 28173.) Head distinctly wider than long; snout slightly rounded at tip; a curving fold crosses head behind eyes and a slight groove can be traced from it, across tympanic region and jaw; tympanum covered by thick skin but its outline can be discerned by its elevated edges, its diameter about two thirds of eye length; snout rounded transversely, the canthus rostralis lacking; a slight depression behind nostril; loreal region strongly oblique; length of eye-opening equal to the distance between eye and nostril, and contained in interorbital distance 1½ times; tongue a rounded oval, free for two thirds of its length, not notched posteriorly; choanae of moderate size, widely separated, the diameter of one contained in the distance between them, four to five times; a broad transverse glandular fold across posterior part of palate, with a smaller, shorter and narrower fold immediately in front of it; no vomerine teeth.

Skin thick, leathery, appearing smooth, but under the lens numerous, small, scattered pits are evident, and skin shows minute granulations; skin on region above tympanum, and extending to above arm insertion, much thickened; surface of shin, except mesially, covered with numerous pearly tubercles, a few of which appear on upper lip; in posterior abdominal region there is a fold

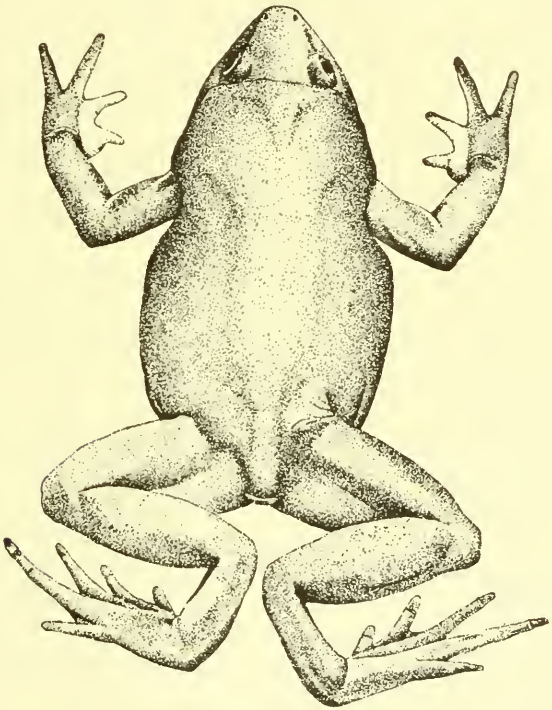

FIG. 69. *Microhyla aterrima* (Günther). K.U. M.N.H. No. 23173; 1000 m. elev. east slope Volcán Poás, Costa Rica; actual snout-to-vent length, 47 mm.

suggesting an abdominal disc, while the whole under surface of abdomen appears to be an extensive nuptial gland that terminates at throat; a few pearly tubercles below anal opening; posterior surface of arm and leg, to a lesser extent hand and foot, with numerous pearly tubercles.

Arm short, fingers tapering, the first finger shorter than second; a large flattened tubercle at base of first finger; palmar pad flattened, scarcely discernible as such; subarticular pads large, the small terminal pads narrower than the fingers; a large patch of nuptial asperities covering dorsal surface of pad and first finger,

the inner and part of the dorsal surface of the second finger and some of the dorsal surface of the hand; another patch borders the inner surface of the third finger; the extremely minute asperities are yellow-white lacking any brown color; no trace of web or lateral finger ridges.

Digits on foot with small terminal discs, narrower than digit; subarticular tubercles large, flat; a moderately large flattened inner metatarsal tubercle, but no trace of an outer; first toe free of web save for a suggestion of lateral ridges; second toe with a narrow inner fringe; between the second and third toes about one-third webbed, the fringe extending on the sides of digits; between third and fourth the web is about half as long as the third digit leaving three joints of the fourth free, the fringe continuing to near tip; between fourth and fifth the web is two thirds the length of the fifth toe.

Color: Nearly uniform black (purplish brown when preserved); chin blackish brown; abdomen dirty light yellow-brown; under side of limbs dark with some grayish clouding; under a lens minute yellow-brown dots visible under skin.

Measurements in mm.: Snout to vent, 47; width of head, at tympanum, 12; snout to dorsal head fold, 8; arm, 27; leg, 64; tibia, 22.5; tarsus and foot, 34.6.

Remarks: Parker (1927) has shown that the genus *Glossostoma* is not tenable, but that the species assigned to it represents probably the most primitive American members of the genus *Microhyla,* retaining, as it does, the largest foot web, and the palatine bone. The largest size known for the species is 55 mm. for the female type. Aside from eastern Costa Rica the species is known to occur in Colombia and northwest Ecuador.

In 1947 I found a single specimen of this species (K.U.M.N.H. No. 28173) under a small log, along an old road passing down the eastern face of Volcán Poás, at an elevation estimated to be 1000 meters. When exposed by the turning of the log the specimen remained motionless.

In 1951 I found this species to be abundant at Moravia in a pile of chips, some 16 specimens being taken at this place. One or two other animals were found in similar localities near by. However, specimens were not encountered elsewhere, and the voice was not heard. Many of the specimens were females.

Microhyla pictiventris (Cope)

Engystoma pictiventre Cope, Proc. American Philos. Soc. vol. 23, Apr. 1886, p. 272 (type locality, Nicaragua); U. S. Nat. Mus. Bull. 32, 1887, p. 18; Günther, Biologia Centrali-Americana. Reptilia and Batrachia, Feb. 1900, p. 209; Nieden, Das Tierreich, Lief. 49, Anura II, 1926, p. 66 (*pictiventris*).

Gastrophryne pictiventris Stejneger, Proc. Biol. Soc. Washington, vol. 23, 1910, p. 166.

Microhyla pictiventris Parker, A Monograph of the Frogs of the Family Microhylidae, 1934, p. 146 (Nicaragua); Dunn, Amer. Mus. Novitates, No. 1419, May 9, 1949, pp. 16. (Nicaragua and Costa Rica).

I have had no specimen of this rare species and include data from the type description.

"One small metatarsal tubercle. Muzzle anterior to eye equal to twice long diameter of latter, and projecting well beyond the mouth. Nostrils lateral, terminal. No fold across occiput. Skin everywhere smooth. First finger shorter than second, which reaches end of muzzle when the limb is extended. When the hind limb is extended forwards the distal end of the astragalus reaches the extremity of the muzzle. First toe very short; second [third?], a good deal longer than fifth; fourth elongate. Color above olivaceus brown. A black band with a very narrow pale superior border extends from the end of the muzzle to the lower part of the groin, the superior border descending posteriorly. No inguinal spot. Below black, with white spots. Those on the abdomen are very large; those on the femora and tibia are smaller, and those on the thorax and gular region are still smaller."

Total length of head and body, 22.5 mm.; length of posterior leg, commencing at groin, 29 mm.; length of posterior foot, 14 mm.; length of astragalar portion, 4.5 mm.

The type is 14196 in the U. S. National Museum.

Remarks: The species is included on the basis of Dunn's (1949) Costa Rican report. Whether or not there are Museum specimens available, actually taken in Costa Rica, I do not know.

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1893a. Ein neuer Laubfrosch aus Costa Rica. Ber. Naturf. Gesellsch. Frankfort am Main, 1892-1893 (1893) pp. 251-252.
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1893b. Für die Reptilien- und Batrachiersammlung. Ber. Senck. natur. Gesellsch. Frankfort am Main, 1892-1893 (1893), pp. XXVIII-XXXI.

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Bufo melanochlorus described as new from "East Costa Rica."

1886. Thirteenth Contribution to the Herpetology of Tropical America. Proc. Amer. Philos. Soc., vol. 23, No. 122, Apr. 1886, pp. 271-287.
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Hylodes polyptychus is described as new.

1893. Second Addition to the Knowledge of the Batrachians and Reptilia of Costa Rica, Proc. Amer. Philos. Soc., vol. 31, 1893, Nov. 17, pp. 333-347.
Lithodytes florulentus, from Boruca, *Hylodes stejnegerianus* from Palmar, and *Leptodactylus quadrivittatus* Buenos Ayres are described as new.

1894. Third Addition to a Knowledge of the Batrachia and Reptilia of Costa Rica. Proc. Acad. Nat. Sci. Philadelphia, 1894, pp. 194-206.
The following forms described: A salamander, *Oedipus robustus,* slopes of Volcán Irazú, and frogs, *Hyla cherrei,* from Alajuela, *Hylella chrysops,* Alajuela and San José, *Lithodytes euryglossus,* San José, *Levirana vibicaria* (new genus and species), Rancho Redondo; Isla Nueva, near the head of Río Sucio on the Atlantic side.

DECKERT, RICHARD

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1924c. Two Closely Related Species of Phyllobates. Copeia, no. 126, 1924, p. 22.

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1931b. The Amphibians of Barro Colorado. Occ. Papers Boston Soc. Nat. Hist., vol. 5, October 10, 1931, pp. 403-421.
Several Costa Rican records given.

1931c. New Frogs from Panamá and Costa Rica. Occas. Papers Boston Soc. Nat. Hist., vol. 5, August 18, 1931, pp. 385-401.
The following are described as new: *Eleutherodactylus talamancae,* Bocas del Toro, Panamá and Monteverde, Zent and Suretka, Costa Rica; *Lithodytes gaigei,* Fort Randolph, Canal Zone; Talamanca Valley, Costa Rica to Darien; and *Centrolene valerioi,* La Palma, are described as new. *Hyla colymba* is from La Loma, Panamá. Several other forms are listed from Costa Rica, some for the first time.

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1949. Notes on South American Frogs of the Family Microhylidae. Amer. Mus. Novitates, no. 1419, May 9, 1949, pp. 1-21, figs. 1-7.
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EATON, T. H.
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KEFERSTEIN, WILHELM
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1868. Ueber einige Batrachier aus Costarica. Arch. f. Naturg., Jahr. 34, vol. 1, 1868, pp. 291-300, pl. VIII-IX.
Seventeen species are reported from Costa Rica. The following are regarded as new species: *Leiyla guentheri* and *Ocdipina uniformis*. Figures are included of the new species described in this and the preceding paper.

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1941. Contributions to the Knowledge of the Amphibia of South America. (Medd. Göteborgs Mus. Zool. Avdel. 88) Göteborgs Kungl. Vetenskaps, och vitterh.-Samh. Handl. Sjätte Föl., ser. B. Band 1, no. 4, 1941, pp. 1-71, figs. 1-38.

NIEDEN, FRITZ
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Catalogue of known Amphibia of the Suborder Aglossa and Phaneroglossa, Section 1. Arcifera.
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PETERS, W.
1873. Über eine neue Schildkrötenart, *Cinosternon Effeldtii* und einige andere neue oder weniger bekannte Amphibien. Mon. Akad. Wiss. Berlin, 1873, pp. 603-618, pl. 5.
Hylodes cruentus, Hylodes rugosus and *Hyla pulverata* are described from Chiriquí, Panamá.

POPE, PHILIP
1941. Notes on a Tadpole of *Dendrobates auratus.* Copeia No. 2, 1941, p. 112.

SCHMIDT, OSCAR
1857. Diagnosen neuer Frösche des zoologischen Cabinets zu Krakau. Sitzungsb. k. Akad Wiss. Math.-Natur. Cl., Bd. XXIV, Heft. 1, Jahrg. 1857, März, pp. 10-15.
New species are described from New Granada and Bolivia. The descriptions are in Latin.
1858. Deliciae Herpetologicae Musei Zoologici Cracoviensis. Beschreibung der im K.K. Museum zu Krakau befindlichen, von J. v. Warszewicz in Neu-Granada und Bolivia gesammelten Ungeschwänzten Batrachier. Denkschr. K.K. Akad. Wiss. math.-natur. Cl. Bd. 14, pt. 2, 1857 (1858), pp. 237-258, pls. 1-3, figs. 1-27.
This is a second paper dealing with the same material. Added details and data are given on the von Warszewicz's collection. Numerous figures. The descriptions are published as *species novae,* although the descriptions must date from the earlier paper.

TAYLOR, EDWARD H.
1948. Two new Hylid Frogs from Costa Rica. Copeia 1948, no. 4, Dec. 31, pp. 233-237, text figs. 1-2.
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1949. Costa Rican Frogs of the Genera Centrolene and Centrolenella. Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 257-270.
Centrolenella spinosa, Centrolenella colymbiphyllum, Centrolenella granulosa and *Centrolenella albomaculata* are described.
1951. Two new genera and a new family of tropical frogs. Proc. Biol. Soc. Washington, vol. 64, Apr. 13, 1951, pp. 33-40. Proposes the genera *Cochranella* and *Teratohyla,* and the family Centrolenidae.

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Certain Costa Rican records mentioned.
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WETTSTEIN, OTTO
1934. Ergebnisse der österreichischen biologischen Costa Rica-Expedition 1930. Die Amphibien und Reptilien. Sitzungsb. Akad. Wiss. Wien, mathem.-naturw. Kl. Abt. 1, Bd. 143, Heft 1 and 2. 1934, pp. 1-39.
Wettstein reports three salamanders, and seventeen species and subspecies of frogs and toads. All save one (an "*Eleutherodactylus* spec?") are referred to known species.

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